BC hydro

An Introduction to the

1990 Electricity Plan

April 1990

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Message from the Chairman

Electricity demand grows out of the choices made by British Columbians. There is a direct connection between growing demand for electricity and the effects of new generation projects on the environment.

This 1990 Electricity Plan contains B.C. Hydro's latest projections of future demand. It also describes the choices required to ensure these needs are met, choices which involve a series of complex trade-offs.

This year's Plan sets priorities which are reflected in Hydro's support for the Power Smart program to promote reductions in electricity demand and the Resource Smart program to improve the efficiency of its existing facilities. To meet long term requirements, additional generating facilities will be required, unless further improvements can be made to the way electricity is produced and consumed.

This plan reflects a clearer sense of direction than existed in the 1989 Resource Plan. But final decisions on the development of future options have not been made. And because future electricity demand remains uncertain Hydro must remain flexible in its planning.

In the coming months, Hydro is asking for public input on the Electricity Plan. We will be meeting with interested groups, individuals, and the larger public and asking them to help us refine Hydro's development strategy. This is an evolutionary process. Hydro wants its development activities to reflect the values of all British Columbians.

INTRODUCTION

This document presents B.C. Hydro's perspective on future electrical services in British Columbia. It includes a plan for the allocation of electricity resources to meet those needs. The information is designed to serve as a catalyst for public discussion. With it, B.C. Hydro is soliciting the views of the groups and individuals that have an interest in the planning process.

In many respects this is an update of the 1989 Resource Plan. But the 1990 Electricity Plan reflects some notable recent developments, such as the Provincial Government's decision to repatriate downstream benefits under the Columbia River Treaty starting in 1998. Additional information has also been obtained on several other programs initiated in the past year. So this document goes further, describing B.C. Hydro's progress in implementing initiatives set out in last year's plan.

THE PLANNING PROCESS

B.C. Hydro strives for the most efficient use of British Columbia's electricity resources to meet future electrical needs. This is one way Hydro fulfils its mandate to support economic growth throughout the province.

The 1990 Electricity Plan gives priority to investments that will improve the efficiency of electricity use. Hydro's planners are wrestling with a series of trade-offs. Efficiencies are sought, both in the way electricity is produced and how it is used. Hydro is trying to reduce total costs. It must maintain or improve reliability and security of supply. There is a need for better customer service. Yet throughout the planning process, enough flexibility must be maintained to meet future uncertainties.

B.C. HYDRO'S ELECTRIC SYSTEM

B.C. Hydro's transmission system has almost 17,000 km of lines operating at voltages from 500 kV down to 69 kV. Distribution voltages are typically below 69 kV. High transmission voltages are needed because major generation resources are far away from most customers.

Hydro's existing generation system is predominantly hydroelectric. The integrated system has 29 hydro plants, one conventional gas-fired thermal plant (Burrard) and two combustion turbine plants. The total system capacity is 10,395 MW.

Hydro coordinates its operations with both Cominco and West Kootenay Power and Light facilities under the Kootenay Canal Agreement. The Columbia River system operation is coordinated with the U.S. Pacific Northwest generating system under the Columbia River Treaty. There is also increasing coordination with TransAlta and Alcan.

Significant progress has been achieved in Hydro's planning process. The uncertainty of future supply and demand is now part of all projections. A broad range of potential outcomes is examined when making planning decisions on both the supply and demand sides. Pricing is also being addressed as a policy instrument for balancing supply and demand.

Environmental and other socio-economic impacts must be recognized. These impacts are not easily quantified. The value British Columbians place on these impacts should be reflected in the utility's decision-making process. So, Hydro has committed itself to a policy of open discussion and consultation. To curb the growing demand for electricity, the public is also being asked to contribute to improving the efficiency of electricity use.

CORPORATE POLICIES AND DIRECTIONS

The Environment

By generating and transmitting electricity, Hydro inevitably affects the natural resources of the province. Therefore B.C. Hydro has adopted an Environmental Policy. The policy states: "In carrying out its business, B.C. Hydro will minimize adverse effects on the natural and social environment and actively pursue opportunities to manage these resources for the benefit of future generations."

Specific actions have already been taken. Hydro has adopted new regulations for management of hazardous chemicals. It has launched a corporate environmental audit. A recycling program is under way. A vehicle emission study is being carried out on B.C. Hydro's fleet.

Public Consultation

B.C. Hydro is committed to obtaining public input into the planning process. Information will be gathered on public attitudes towards the environment, economic development, lifestyles and other social concerns.

The focal point of Hydro's public consultation for this year will be the annual Energy Forum to be held in May at Prince George.

Public consultation will continue on specific projects, including the Lower Columbia projects and Peace Site C. Further discussions are planned on the Kelly Lake to Cheekye transmission, and potential inter-ties with U.S. utilities

REVIEW OF LAST YEAR'S EVENTS

- B.C. Hydro and two provincial ministries co-sponsored the second annual Electric Energy Public Forum. The topic was Energy and the Environment.

- B.C. Hydro pursued several initiatives aimed at encouraging independent power production. Agreements in principle were reached with NW Energy Developments for a 55 MW woodwast project at Williams Lake and with Westcoast Energy Inc. and CU Power for a 105 MW cogeneration project at Taylor.

- B.C. Hydro asked for expressions of interest in self-generation from its larger customers.

- The Provincial Government announced that the downstream benefits under the Columbia River Treaty would be repatriated as they become available, starting in 1998/99.

- Five Power Smart programs were launched: the Efficient Lighting, Non-Integrated Areas, High Efficiency Motors (revised), Efficient Compressed Air and New Plant Energy Audit programs.

- About $12 million was spent on development studies for the Keenleyside and Peace Site C projects as part of Hydro's contingency planning.

- The B.C. Utilities Commission held a public hearing into electro magnetic field (EMF) effects on public health of a 230kV transmission line from Parksville to Gold River. The Commission subsequently approved the transmission line.

- The Commission also approved a Certificate of Public Convenience and Necessity for a third transmission line from Williston to Kelly Lake.

Power Smart

The launching of Power Smart, in 1989, underlined B.C. Hydro's commitment to the planning strategy which recognizes the importance of reducing demand. Power Smart is a portfolio of programs designed to create an awareness of energy conservation issues. It encourages customers to use electricity efficiently, using a variety of means including financial incentives.

B.C. Hydro has given Power Smart top priority. The programs are intended to reduce consumption in a cost-effective, sustainable and environmentally conscious manner.

Independent Power Production and Wheeling

B.C. Hydro is encouraging private sector contributions to the supply of electricity. The utility will buy electricity from independent power producers. Several requests for proposals to supply electricity were issued in the past year. Hydro expects the resulting competition will produce more supply options and lower costs. Hydro is also encouraging consumers to supply more of their own power needs (self-generation).

Hydro has also asked the B.C. Utilities Commission to approve a policy which will allow private suppliers to use Hydro's system to transmit electricity within the province. This is generally refered to as "wheeling". If permission is granted, independent power producers would pay a fee to use Hydro's system to transmit power directly to their own customers.

Pricing of Electricity

In November 1989, B.C. Hydro filed formal application for a series of three 3% rate increases over the period to 1991. The rate hearing before the B.C. Utilities Commission generated public discussion on the appropriate pricing of electricity. Discussion centred on the impact expanding the supply of electricity will have on the environment. Hydro is moving to modify the existing rate structure to promote efficiency in energy use.

Export Market

In 1989, Powerex, a B.C. Hydro subsidiary, called for expressions of interest in supplying up to 450 MW of power for the export market. Powerex is now reviewing detailed proposals from selected independent power producers.

Powerex will also market electricity that is judged to be surplus to the province's needs. This is expected to occur in years when river flows generate more electricity than is required to meet demand in the province.

Powerex is also working with Hydro to encourage private sector developments in the province. Powerex will provide opportunities for independent power producers to sell their electricity on the spot market. Producers can sell or buy short term supplies of electricity on a firm or interruptible basis. B.C. Hydro will ensure there is no risk to provincial power customers from these transactions.

THE NEED FOR ELECTRICITY

Assessment of the future demand for electricity is the first step in the planning process. The uncertainty of future demand is a key factor. Flexibility in meeting a range of future demands, therefore, is an important criterion for Hydro's strategy.

The utility uses population and economic projections as well as other outlooks to get a broad picture of electricity requirements. This is supplemented by detailed analyses of how customers now use electricity and how consumption patterns are likely to change.

Probable Economic Assumptions

Economic and demographic factors decide future electrical requirements. Population growth through 1999 is expected to be about

1.6% annually, dropping to about 1.3% in each of the following 10 years. B.C.'s population is expected to reach 3.6 million by 1999 and 4.1 million in 2009. Migration to B.C. from other provinces is a critical variable.

The province's Gross Domestic Product (GDP) is expected to average 2.8% real growth over the next ten years. In the following decade real annual growth in the GDP is expected to drop to 2.3%. Electricity prices are expected to increase at less than the rate of inflation for the first 10 years.

Probable Electricity Forecast

The demand for electricity in British Columbia is forecast to increase each year. B.C. Hydro expects continuing improvements to the efficiency of electricity use will limit demand growth.

A moderate growth of 2.0% is forecast for residential sales over the next 20 years. Over the same period, commercial sales are projected to grow by about 3.0% annually. Projections for industrial sales show slightly slower growth of about 2.8%. Electricity intensive mechanical pulping is expected to be the main source of new industrial demand.

Power Smart should lower the expected overall demand growth rate from 2.5% to about 2.0%.

DEVELOPMENT OPTIONS

B.C. is fortunate in having a variety of options available to reduce future demands or increase future supplies of electricity:

Power Smart: This is the name given to Hydro's strategy to improve the efficiency of electricity use. It includes various programs that are designed to produce lasting reductions in demand. Separate programs address the residential, commercial and industrial sectors.

Resource Smart: This is the name given to Hydro's program to ensure that full economic use is made of the capacity and energy potential of our existing facilities. The program reviews options for increasing the output of existing facilities such as adding additional capacity, retrofitting with more modern equipment, raising operating levels and diversions of additional water. Many of the Resource Smart projects have little or no environmental impact.

Coordination and Purchases: These include agreements with other utilities or larger industrial firms to operate their respective systems in coordination with Hydro's. Coordinated operation results in benefits for both parties. Hydro recently completed coordination and purchase agreements with Alcan and is continuing discussions with Bonneville Power Administration in the U.S. and with TransAlta Utilities representing the Alberta Interconnected System.

Self-generation and Cogeneration: This is generation of electricity by customers for their own use, thereby reducing the demand on B.C. Hydro's generation. In the case of cogeneration, significant efficiency improvements can be obtained because energy that would normally be wasted is used for other purposes. The forest industry as a whole has an estimated potential for 500 MW of new self-generation in addition to about 475 MW of self-generation that exists today.

Downstream Benefits: Under the Columbia River Treaty the Canadian Entitlement to downstream power benefits was sold to the U.S. for a period of 30 years beginning with the commencement of operation of each Treaty project (Duncan, Mica and Arrow). These 30 year sales begin to expire in 1998. At that time the power benefits will be returned to the province. The Government has not yet decided on the allocation of these benefits within the province.

Small Hydro: These include hydroelectric developments with only small amounts of reservoir storage that would not alter the existing seasonal variations in river flows.

Major Hydro in Developed Basins: These would be medium to fairly large projects on partially developed rivers such as the Peace and Columbia. Projects such as Peace Site C, Murphy Creek and Border would be included.

Major Hydro in Undeveloped Basins: These would be medium to large developments in undeveloped river basins such as the Elaho, Homathko, Stikine, Iskut or Liard.

Waste-fired Thermal: These would generally be small to medium developments utilizing a variety of waste products such as wood waste, municipal solid waste, landfill gases or coal waste. In some cases, such as wood, the waste products are already being burned.

Gas-fired Thermal: Thermal generation utilizing natural gas has the advantage of being a relatively inexpensive and established technology. New developments would likely utilize more advanced technology resulting in higher efficiencies than older projects.

Coal-fired Thermal: This could include major new developments such as the proposed Hat Creek project considered for development in the late 1970's.

Alternative and Emerging Technologies: These include alternative energy sources such as wind, wave, geothermal, tidal, and solar and developing technologies such as fuel cells, superconductors and fusion.

EVALUATION OF OPTIONS

The first question that must be answered in developing the Electricity Plan is which options should be utilized?

Each option has different attributes that make it more or less acceptable than the others. Each has a different cost. Each has a different reliability and availability in B.C. Several of the options have uncertain costs, for example, projects with high operating or fuel costs are subject to future inflation.

Each option has different impacts on the environment. Large hydro projects raise difficult land-use questions. Many of the thermal options would contribute in varying degrees to the "greenhouse effect".

It is not always possible to quantify each of these attributes on a comparable basis. For example, how does a slightly higher cost trade off against flooding of more land or greater carbon-dioxide production? Individuals differ in the relative value they place on these impacts.

Several attributes of each option are indicated in Exhibit 1. This table provides qualitative information on the various attributes, for example environmental impacts are categorized as small, medium, large, very large, etc. The weighting factors in the table reflect Hydro's judgements. Only large scale developments were considered.

Based on this and other assessments, Hydro has established development priorities for the options. The first priority is Power Smart, or conservation. Next is coordination and purchases, followed by Resource Smart, or increased utilization of existing facilities.

Next Hydro will encourage development of private sector supply and self-generation. Hydro expects that many of the private sector developments will be small hydro developments and waste-fired or gas-fired thermal projects.

Hydro projects on partially developed river basins are next. Lastly, Hydro will consider hydro projects in undeveloped basins and new thermal generation. These priorities are reflected in the development strategy.

The next question that must be answered is how much of each option should be developed and when? Because of the limited amount of electricity available from many of the options, the priority established above provides much of the answer.

DEVELOPMENT PRIORITY

1. Power Smart
2. Coordination and Purchases
3. Resource Smart
4. Private sector generation
5. New hydro generation in developed basins
6. New hydro generation in undeveloped basins

Over the next two decades British Columbia's annual electricity demand is expected to increase by about 30 000 GW.h.

In the 1990s, Hydro's ongoing Power Smart, coordination and purchase agreements with Alcan and Resource Smart initiatives will all be required to meet the projected demand growth. Hydro will also encourage new self-generation and cogeneration developments. These facilities will be acquired as opportunities arise. Additional purchases from independent power producers will also be required.

In the decade beyond, the choices are somewhat harder. Additional Power Smart programs and Resource Smart projects will be required. In addition, assuming no major break through in alternative and emerging technologies, Hydro proposes that the Site C project on the Peace River and the Murphy Creek and Border projects on the Columbia River be constructed. These rivers are already developed and flows are highly regulated. The projects are relatively attractive economically and each is moderate in size.

Additional new resources may be required in the 2005 - 2010 period, but specific resources have not been identified to meet these needs.

DEVELOPMENT STRATEGY

Once the choice of options is established, the development strategy must be assessed. Questions such as who builds the projects, what are the impacts of construction in the local areas and what is the role of major projects must be answered.

B.C. Hydro and the provincial government are encouraging private sector participation in the future supply of electricity. This emphasis will foster competition for supply options and will lead to lower costs and increased diversity of supply. In this context, many of the projects identified in the Electricity Plan, including both large and small projects, may be developed by the private sector.

The Electricity Plan includes several projects in the area of Castlegar and Trail, including five Resource Smart projects (Seven Mile 4, Waneta Expansion, Brilliant Expansion, Keenleyside and Duncan), Murphy Creek and Border. Hydro proposes to schedule these projects to minimize construction costs and to reduce disruption to the local economy. The timing of individual projects will be adjusted to maintain a reasonably stable workforce in the region. This will benefit Hydro by reducing its costs of re-training workers and benefit the region by reducing the boom and bust cycle that could otherwise accompany this type of development.

RISK MANAGEMENT

The B.C. Hydro system is highly reliable. Customers expect the utility to maintain this high level of service. So the Electricity Plan includes options with proven availability and using only proven technologies. Improvements to the transmission system are also designed to stringent reliability standards.

The development strategy must protect against both the risks of under-supply and over-supply. Over-supply risks occur when projects are built too early, potentially causing surpluses of electricity. Under-supply risks occur when projects are not built in time and higher cost generating options must be utilized to meet demands. In the extreme, shortages of electricity could occur causing increased costs

for both Hydro and its customers. An illustration of these risks is provided in the figure below.

There are three basic elements in Hydro's risk management strategy:

(i) Under-supply risks are reduced by bringing new generating facilities to shelf-ready status. This reduces construction lead times. Options to acquire additional supplies of electricity have also been identified.

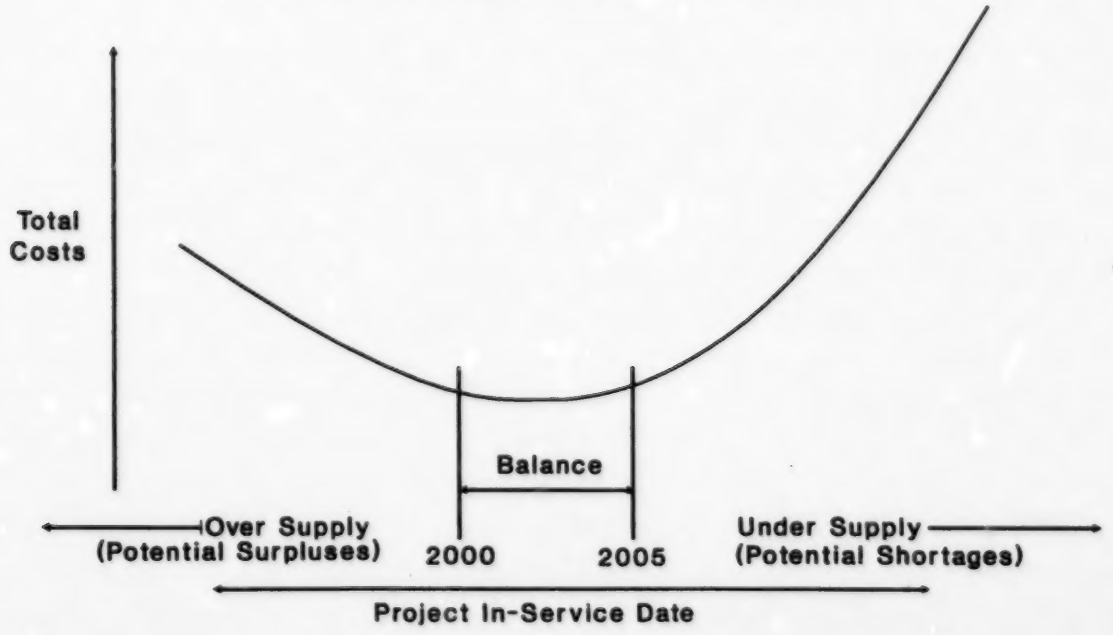
(ii) Over-supply risks can be partially met by marketing surplus electricity to the U.S. Another strategy is to offer temporary industrial discount rates to encourage economic development.

(iii) Balancing of these risks is achieved through on-going review and monitoring of all current initiatives. The introduction of a portfolio of supply and demand options further reduces the total risk level.

Peace Site C plays a key role in this risk management strategy. Current studies indicate that it will be required by about 2002. However, if demands grows faster than expected, or other resources cannot be developed, the project could be advanced by 1-4 years. Similarly, project commitments will be deferred as long as possible to protect against over-supply. Engineering work, needed to reduce the time required to bring the project into production after receiving approvals, will be carried out when appropriate.

Exhibit 2 compares the expected firm energy capability of the options included in the development strategy to the probable range of forecast demand.

OVER/UNDER SUPPLY RISKS



TRANSMISSION REQUIREMENTS

The objective of the transmission development strategy is to shape tomorrow's electric system to assure customers of a reliable, efficient supply of electricity while minimizing the effects on the environment. The development of the transmission system is influenced by the location and magnitude of new generation sources and by regional changes in the demand for electricity.

Most of B.C. Hydro's transmission system is designed to be capable of withstanding the failure of a major element at peak periods. Also, disturbances within the B.C. Hydro system should not adversely affect neighbouring utilities.

Additional transmission will be required to integrate the Lower Columbia and Peace Site C developments.

Approximately 70 percent of the electricity produced is consumed in the Lower Mainland and Vancouver Island. The transmission system into the Lower Mainland is presently operating at capacity. Studies of the Lower Mainland transmission corridors are being conducted.

Resource Smart includes cost-effective improvements to the existing transmission system. Various reinforcements have been added to the system. More are planned to postpone the need for new lines as long as possible.

ACTION PLAN

The following actions will be taken by B.C. Hydro during the fiscal year 1990/91 to carry out this Electricity Plan.

Power Smart Programs

Power Smart programs will be aggressively promoted by B.C. Hydro across the province. Key new programs will be introduced for residential, commercial and industrial customers.

Testing and development of new initiatives will continue. These include retrofit programs, more efficient building designs and controls, and high efficiency lighting systems. An allocation of $40 million has been made for Power Smart programs in 1990/91.

Resource Smart

Opportunities to improve the output of B.C. Hydro's existing generation system and to reduce transmission losses will be actively pursued.

A capital budget of $10 million plus an additional $1.8 million for studies have been allocated to Resource Smart for 1990/91.

In addition, B.C. Hydro will continue to work with its engineering consultants towards the possible licensing of the Keenleyside project.

Discussions with Cominco on the proposed expansion of the Waneta and Brilliant projects will continue in the coming year. Further studies will continue on other Lower Columbia projects.

Purchases and Coordination

An agreement for coordinated operation of the Columbia River System with Bonneville Power Administration should be completed this year.

Hydro is negotiating an agreement on coordinated operation with Alberta Interconnected System in 1990/91. The proposed agreement could include purchasing energy from Alberta as well as exchanges of capacity and energy.

Independent Power Production and Wheeling

B.C. Hydro expects to finalize discussions with independent power producers responding to its call for 150 MW of new generation. This will complete the process that began with a request for proposals in December 1988. Other agreements are expected with several independent power producers for a further 25 MW of new generation from small power sources.

Requests for proposals for an additional 150 MW of generation from independent power producers will be issued in September 1990.

B.C. Hydro also will file an application with the B.C. Utilities Commission for approval of an interim wheeling policy in 1990. The policy, to be reviewed after two years, will cover long-term firm wheeling of power to serve demands in B.C. The policy is designed to provide additional incentives for the development of independent generation.

Self-Generation and Cogeneration

B.C. Hydro is evaluating replies to its December 1989 request for expressions of interest in this field of activity. Hydro wants to build on its recent cogeneration agreement with Howe Sound Pulp and Paper. Meanwhile, the utility will actively help its large customers to evaluate their self-generation potential.

Contingency Plans

Work is proceeding on Peace Site C environmental and socio-economic studies needed to satisfy concerns about impacts and identify potential mitigation and compensation. A joint provincial and federal hearing on the environmental implications of the Site C project is anticipated.

Engineering work, needed to reduce the time required to bring the project into production after receiving approvals, will be carried out when appropriate.

Major Transmission Projects

Construction will soon begin on a third Williston to Kelly Lake 500 kV transmission line. Hydro is planning a second Skeena to Kitimat 287 kV line. These lines will provide firm transmission capability for electricity purchased from Alcan's Kemano Completion Project.

Preparations will continue for submission, in the fall of 1990, of an application for an Energy Project Certificate for a second Kelly Lake to Cheekye 500 kV transmission line. This line will serve load growth in the Lower Mainland and on Vancouver Island.

Total expenditures of about $127 million on reinforcements to the electric transmission system are budgeted in 1990/91.

Rate Design Application

B.C. Hydro will analyse how its rate structure may be modified to encourage improved efficiency in the utilization of electricity and will file an application for changes with the B.C. Utilities Commission by the end of 1990.

Export Activities

B.C. Hydro will support the development of export opportunities by studying transmission interties with Puget Sound Power and Light and Washington Water Power. Construction of either of these interties within B.C. is subject to Powerex establishing sales agreements.

EXHIBIT 1
ASSESSMENT OF OPTIONS

	Availability	Public Acceptance	Cost	Uncertainty	Environmental Impact	Socio-Economic Impact	Transmission Impact	Weighted Sum
Weight[1]	NA	20	15	5	15	5	10	
Power Smart	1	0	1	2	0	0	0	25
Coordination	1	1	1	1	1	2	2	85
Resource Smart	1	1	2	1	1	2	2	100
Hydro								
Small developments	1	1	2	2	1	2	2	105
Peace/Columbia	1	2	2	1	2	3	3	150
Undeveloped Basins	1	2	2	2	3	2	3	165
Thermal								
Coal	1	3	2	1	3	1	3	175
Gas	1	2	2	3	2	1	1	130
Nuclear	1	4	2	2	2	3	1	175
Woodwaste	1	1	2	2	1	1	3	110
Alternative Technologies[2,3]								
Wind	2	2	4	3	2	1	3	180
Geothermal	2	2	4	3	2	2	3	185
Tidal	1	2	4	3	3	2	3	200
Municipal Solid Waste	1	2	3	2	2	1	1	140
Emerging Technologies[2,3]								
Fuel Cells	3	2	3	2	1	1	1	125
Fusion	4	2	3	3	1	3	1	140
Wave	3	2	3	3	2	1	3	165
Solar	3	2	4	3	2	1	1	160

1. Impacts are ranked on a scale of 0-4. Smaller numbers indicate greater availability, and public acceptance, lower cost, less uncertainty and less impact. The weights reflect Hydro's current judgements and will be adjusted to reflect changing values. Others may differ in the relative values they place on these impacts.
2. Only large scale developments are considered. The impacts of these resources may be quite different for small scale developments.
3. Ongoing monitoring of experience around the world is maintained. Certain demonstration projects may be approved.

EXHIBIT 2
1990 ELECTRICITY PLAN - DEMAND FORECASTS AND FIRM SUPPLIES
Millions of kW.h

					Options In-service at End of Five Year Period			
Fiscal Year Ending March 31st	1991	1992	1993	1994	1995	2000	2005	2010
DEMAND								
25th Percentile	44460	45790	46770	47820	48830	53650	58330	63990
Probable	45880	47700	49010	50520	51860	58710	66630	73670
75th Percentile	47500	49780	51390	53330	55100	64080	74150	86580
Power Smart	300	760	1220	1690	2090	3440	3900	4300
Customer Self-Generation[1]	0	0	325	650	975	1300	1300	1300
Net Demand (Probable)	45580	46940	47465	48180	48795	53970	61430	68070
EXISTING AND COMMITTED SYSTEM								
Firm Hydro	42560	42560	42560	42560	42560	42560	42560	42560
Thermal	3720	3720	3720	3720	3720	3720	3720	1600
Downstream Benefits[2]	0	0	0	0	0	2060	3130	2690
NEW SUPPLY								
Resource Smart	500	600	800	1000	1300	2600	3395	3395
Purchases & Coordination[1]	3040	3015	2615	2215	2345	3520	3520	3520
IPP's[1]	0	50	100	630	2350	2400	2400	2400
Peace Site C[3]	0	0	0	0	0	0	4570	4570
Murphy Creek[3]	0	0	0	0	0	0	0	1450
Other New Generation[3]	0	0	0	0	0	0	0	7720
SURPLUS/DEFICIT								
25th Percentile	5660	4915	4570	4645	6510	7950	10165	11515
Probable	4240	3005	2330	1945	3480	2890	1865	1835
75th Percentile	2620	925	-50	-865	240	-2480	-5655	-11075

Notes:

1. The contribution of these options may be increased to accommodate changes in demand. Deficits would be reduced accordingly.
2. The downstream benefits are a provincial resource. No allocation to any specific demand or utility has been made.
3. The timing of these supplies may be adjusted to accommodate changes in demand.

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A Perspective on Supply and Demand Options

May 1990

BC
B685
D:E585
1990
c.3

British Columbia Cataloguing in Publication Data
Main entry under title:
Electricity plan. — 1990-

Continues: B.C. Hydro. Resource Planning. Twenty-year resource plan for the period . . . ISSN 0843-5707
ISSN 1180-2561

1. B.C. Hydro. 2. Electric power - British Columbia - Planning. I. B.C. Hydro. Resource Planning

HD9685.C33B322 333.79'32'09711

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EXECUTIVE SUMMARY

This document presents B.C. Hydro's perspective on the future electrical services that will be required in this province and the allocation of resources to meet that need. It reaffirms B.C. Hydro's committment to improving efficiency in the production and use of electricity and to its objective of supporting economic development in B.C.

Electricity requirements are projected to increase to 58 710 GW.h by 1999/2000 and 73 670 GW.h by 2009/10. This is an average annual growth rate of 2.7%. Analysis of the uncertainty in the demand forecast indicates that there is a 50% chance that the 20 year growth rate could be outside the range of 2.0 to 3.5 percent.

British Columbia has a number of options that could be utilized to meet future electricity needs. The options were evaluated with respect to their public acceptability, cost-effectiveness and their environmental and socio-economic impacts. The impact on transmission requirements was also assessed.

This analysis resulted in the following preference order for the development of options to meet future electricity needs:

- Power Smart
- coordination and purchases
- Resource Smart
- IPP's and customer self-generation
- hydro on developed river basins
- hydro on undeveloped basins and new thermal generation

The Electricity Plan indicates that in the 1990's, B.C. Hydro's ongoing Power Smart, coordination and Resource Smart initiatives will all be required to meet the projected demand growth as will purchase agreements with Alcan and Alberta. Additional purchases from independent power producers and additional customer self-generation will also be required.

After the turn of the century, additional Power Smart and Resource Smart projects will be required. Hydro also proposes the development of the Peace Site C project and the completion of the Lower Columbia development. Hydro proposes to schedule the Lower Columbia projects in a way that will minimize disruption to the local economy by maintaining a reasonably stable workforce in the region.

In Hydro's proposed risk management strategy, under-supply risks can be reduced by bringing projects to shelf-ready status to reduce project lead times. Over-supply risks can be reduced by marketing surplus electricity to the U.S. or by offering temporary industrial discount rates. Balancing of these risks is achieved through the on-going monitoring of current initiatives. The introduction of a portfolio of supply and demand options is an important step towards reducing total risk.

Peace Site C plays a key role in this risk management strategy. Environmental and socio-economic studies are proceeding. Engineering work, needed to reduce the project lead time, will be carried out as appropriate.

The transmission system is greatly influenced by the fact that approximately 70% of the present demand for electricity is in the Lower Mainland and Vancouver Island areas and that 75% of future growth is expected to be in these areas. Transmission corridor planning studies are presently underway. The Resource Smart program includes investing in cost-effective improvements to the transmission and distribution systems.

1.0 INTRODUCTION

B.C. Hydro is a provincial crown corporation established in 1962 to generate, transmit and distribute electricity. B.C. Hydro's Board of Directors is appointed by the Lieutenant-Governor in Council, and is responsible for the overall direction of the corporation. The corporation's activities are regulated by the British Columbia Utilities Commission.

Hydro serves more than 1.2 million customers in an area containing over 92 percent of British Columbia's population. Most of the electricity is generated by modern hydroelectric plants which are linked to customers by an interconnected system of transmission lines. Those remote communities not connected to this integrated system are served by small local generating plants.

1.1 THE 1990 ELECTRICITY PLAN

This document presents B. C. Hydro's perspective on the future electrical services that will be required in this province and the development options to meet that need. The purpose of this report is to provide information that will serve as a catalyst for discussion between B.C. Hydro and the various segments of society which are stakeholders in the planning process.

This report reaffirms B.C. Hydro's committment to improving efficiency in the production and use of electricity through its Power Smart and Resource Smart programs, and to its objective of supporting economic development in B.C.

The electricity plan presents a balanced development strategy which would meet future electricity requirements consistent with provincial and corporate policy guidelines in a manner that is acceptable to the majority of stakeholders. Risk management strategies have also been developed to effectively deal with future uncertainties.

1.2 REVIEW OF LAST YEAR'S EVENTS

A number of important events during the past year significantly influenced the planning process.

- B.C. Hydro, the Ministry of Energy Mines and Petroleum Resources and the Ministry of Environment sponsored the Second Annual Electric Energy Public Forum to discuss Energy and the Environment.

- B.C. Hydro pursued several initiatives aimed at encouraging independent power production. Proposals were sought for projects in both the over and under 5 MW categories. Agreements in principle have been reached with NW Energy Development for a 55 MW woodwaste-fired project in Williams Lake and with Westcoast Energy Inc. and CU Power for a 105 MW gas-fired cogeneration project at Taylor, near Fort St. John.

- B.C. Hydro entered into an agreement with Howe Sound Pulp and Paper to assist them in the installation of woodwaste-fired generation which will provide 700 GW.h of load displacement annually. Expressions of interest for self-generation or load displacement projects have also been requested from B.C. Hydro's other major customers.

- B.C. Hydro, in consultation with the Provincial Government, adopted an 8% discount rate (net of inflation) for long-term planning purposes. Previously the discount rate was 6%. The effect of this change in economic criteria is to provide a more equitable assessment of proposals from the private sector.

• The B.C. Utilities Commission conducted a public hearing on a 230 kV transmission line from Parksville to Gold River on Vancouver Island, specifically to deal with concerns about electromagnetic field (EMF) effects on health. This was the first hearing held by the Commission concerning this issue. Approval for this line was subsequently granted.

• A Planning Committee was formed, within B.C. Hydro, to focus on long-range electricity planning, balancing all aspects of generation, transmission, demand-side management, and strategic rate development. It will provide direction for the development and implementation of a fully integrated resource planning process at B.C. Hydro.

• A request for approval of rate increases over the next 3 years was filed with the B.C. Utilities Commission. This marked a change in pricing policy from one based on historical costs to one based on the cost of new supply.

• The Provincial Government announced that the downstream benefits resulting from the Columbia River Treaty would be repatriated as they become available, starting in 1998/99.

• The B.C. government introduced the concept of environmental credits as a premium on the purchase price of electricity from sources which have positive environmental impacts.

• Five Power Smart programs were launched: the Efficient Lighting, Non-Integrated Areas, High Efficiency Motors(revised), Efficient Compressed Air and New Plant Energy Audit Programs.

• Approximately $12 million was spent on development studies for the Keenleyside and Peace Site C projects as part of B.C. Hydro's contingency planning.

• An agreement was signed with Alcan for the long-term purchase of electricity from the Kemano Completion project and for coordination of its operation with the B.C. Hydro system.

1.3 THE PLANNING PROCESS

B. C. Hydro is developing an integrated resource planning process (also referred to as least-cost planning) to ensure an effective balance amongst multiple objectives which include:

-maintaining reliable customer service,
-minimizing revenue requirements,
-improving efficiency of electricity generation, transmission and use,
-supporting economic growth, and
-protecting the environment.

While many elements of this process are still being developed, the current planning process incorporates a number of these objectives.

The first step in the planning process is to forecast future electricity requirements and to define the range of uncertainty associated with this forecast. The planning process then considers a variety of demand-side and supply-side options with a consistent treatment of their contributions and costs. The concept of "costs" is expanded to not only include economic costs but also environmental and societal impacts.

The planning process includes public consultations to reconcile the values of a variety of stakeholders, addressing the question of "least cost to whom?". The planning process must also consider the uncertainty of future events such as growth in demand, actual contribution from planned resources, interest rates and fuel prices. Developing an Electricity

Plan requires making trade-offs to achieve a balanced set of options which remains viable under a range of possible futures.

The forecast of future electricity requirements is discussed in Section 2 of this document. In Section 3 the development options are identified. They are evaluated in terms of a number of broadly based criteria. The resulting preference order ranking of development options was used to determine the Electricity Plan presented in Section 4. The Plan is presented in terms of a Development Strategy and a Risk Management Strategy (Section 5) which deals with the challenges of meeting uncertain future needs. Section 6 incorporates transmission development strategy into the Electricity Plan. The Action Plan in Section 7 identifies the activites required in the upcoming year associated with the Electricity Plan.

Appendices A and B provide details on planning assumptions and criteria and on development options, respectively.

The choice of projects in the Electricity Plan determines the marginal cost of electricity which is used for evaluation of new projects, modifications to existing facilities, purchases from IPP's and Power Smart programs. The marginal cost of electricity is discussed in Appendix C.

1.4 POLICY AND PLANNING FRAMEWORK

B.C. Hydro's objectives of achieving the most efficient use of resources, supporting provincial economic development and providing superior customer service align closely with the provincial government's goals of economic growth, regional development, diversification, and concern for the environment. A number of corporate policies which are consistent with provincial government directives have been developed to guide the planning process and establish the planning priorities.

Environmental Policy

In the process of generating and supplying electricity, B.C. Hydro inevitably affects the natural and social environment in the province. B.C. Hydro has developed the following Environmental Policy that formalizes the Corporation's environmental values and its approach to assessing the environmental implications of its actions:

"In carrying out its business, B.C. Hydro will minimize adverse effects on the natural and social environment and actively pursue opportunities to manage these resources for the benefit of future generations."

Based on this policy, B.C. Hydro will pursue options which minimize environmental impacts. High priority is given to programs which improve the efficiency of energy utilization and production and to projects which have potential environmental benefits.

Private Supply

The provincial government and B.C. Hydro are facilitating the development of private sector participation through customer self-generation and purchases from independent power producers (IPPs). Private power production achieved through a competitive market basis will enhance economic and regional development in B.C. and increase the diversity of supply. IPP project proposals could encompass the full range of options identified in this Plan.

IPP projects will be subject to government and regulatory review to insure that all economic and environmental issues are addressed prior to project approval. The ranking of IPP project proposals will be influenced by their environmental impact. The

B.C. Government has announced that projects with a positive environmental impact will be eligible for a premium. In addition, the ranking of IPP's will reflect their value to the electrical system. For example, an IPP's location may reduce the need for transmission capability into a particular area of the province.

Rate Policy

B.C. Hydro is moving towards using its rates as a policy tool. The recent application for three 3 percent rate increases is intended to make the price of electricity reflect the cost of meeting increasing future demand. Increasing rates will encourage investment in energy efficiency measures thereby reducing the growth in future demand. Regional rates which reflect the cost of transmitting energy to that region could be used to promote regional development.

Public Consultation

Environmental impacts must be recognized, but since these are not easily quantified, the assessment of these impacts by the citizens of B.C. must be reflected in the decision-making process. For this reason, B.C. Hydro has made a commitment to consultation with all levels of government and the public.

The other important aspect of public involvement is participation in demand-side initiatives. To curb the growing demand for electricity B.C. Hydro must elicit a commitment from the public to improve the efficiency of electricity use.

Electricity Trade Policy

Powerex is a wholly-owned subsidiary of B.C. Hydro responsible for electricity trade. Powerex will facilitate the development of private sector generation and associated transmission to serve export customers where returns under long-term contracts are sufficient to compensate British Columbia for all costs, including environmental costs, and to yield a profit. Generation resources will be available for domestic service following the contract period. B.C. Hydro's role is to provide Powerex with selected support services such as wheeling and storage for a fee. B.C. Hydro will ensure through Powerex that domestic customers are insulated from risk and that the reliability of the electric system is maintained or improved.

In addition, because the B.C. Hydro system is predominantly hydro-electric, it has, from time to time, surplus capability as a result of variable water conditions. This creates energy which is surplus to domestic needs. Transmission capacity is also available during domestic off-peak load demand periods. Such surpluses are made available to Powerex for electricity trade on the basis that Powerex returns to B.C. Hydro all costs incurred plus a profit. Powerex negotiates sales and purchase contracts and maintains the required export licences. Powerex will also market surplus energy and capacity from Alberta.

Power Pool Operation

Powerex will be offering additional opportunities for independent power producers and other suppliers to participate in spot market transactions for electricity by operating a Power Pool. This Power Pool will provide a mechanism that will allow producers to sell and purchase short-term supplies of both firm and interruptible power and energy. This will allow producers to continue to meet their commitments during unit forced outages and to schedule their operation to take advantage of short-term low-cost surpluses.

All Power Pool transactions will be short-term (i.e. less than one year) in nature and will be based on spot market prices. Prices will be quoted for hourly, daily, monthly and six month transactions.

2.0 THE FORECAST OF FUTURE ELECTRICITY DEMAND

The role of the demand forecast in electricity planning has continued to evolve at B.C. Hydro. The relationship between the price of electricity and demand is becoming better understood. The uncertainty in future demand growth influences the planning process. Flexibility in meeting possible future demands is an important criterion by which development options and alternative plans are judged.

The demand forecast quantifies how much electricity will be needed to support projected economic growth in the province and it also indicates the uncertainty inherent in attempts to predict the future.

The forecast is developed by residential, commercial and industrial sectors. The 20-year projections of future requirements are updated annually. The following information is summarized from B.C. Hydro's report "Electric Load Forecast 1989/90 to 2009/10".

Both top-down and end-use forecasting techniques are used. The top-down approach is the use of population and economic forecasts and sectoral outlooks to project the household formation, commercial activity and industrial production that influence the need for electricity. The end-use focus consists of analyzing how various customers presently use electricity and how consumption patterns are likely to change in the future. The effects of energy price changes are factored into the forecast by first establishing the scope customers have for changing their electricity use.

The major factors that determine the forecast of electricity requirements are the economic and demographic assumptions. The economic projections are based on input obtained from the Ministry of Finance and Corporate Relations. The B.C. economy as measured by the Gross Domestic Product (GDP) is forecast to average 2.8% real annual growth over the period 1989 to 1999 and 2.3% in the following 10-year period to 2009. The main growth sectors through 1999 in the industrial area are projected to be paper and allied products manufacturing and non-resource based manufacturing. In the commercial area, trade and services are expected to be the highest growth sectors. Growth of the commercial sector is projected to be higher than the industrial sector throughout the 20 years.

Population growth of about 1.6% on an annual basis was projected through 1999 and 1.3% in the following 10-year period through 2009. In-migration, particularly inter-provincial, is the critical variable in these population projections since the natural increase is expected to be relatively constant.

Electricity prices were assumed to decline in real terms by 1.5% per year for the first 10 years and remain flat in real terms thereafter in line with B.C. Hydro's requested rate increase. Natural gas and light fuel oil prices are expected to increase marginally in real terms. Natural gas is projected to maintain its competitive advantage over electricity throughout the 20-year period.

2.1 PROBABLE DEMAND FORECAST

Electrical energy requirements are projected to increase from 44 380 GW.h in 1989/90 to 58 710 GW.h in 1999/2000 and 73 670 GW.h in 2009/10 for an annual average growth rate of 2.7%.

By comparison, in last year's forecast the gross requirements by 1999/2000 were estimated at 56 980 GW.h and 73 850 GW.h

by 2009/10. The growth rate is now projected to be higher in the early through late 1990's but, in the longer term, the growth rate lessens reflecting lower long term GDP projections.

For the 1989 forecast, essentially the same range as developed for the 1988 forecast has been assumed. Three future economic growth scenarios were developed by the Ministry of Finance and Corporate Relations. Specialists with the Ministry also developed an overall probability for each of the economic scenarios. B.C. Hydro staff, with the assistance of specialists, developed probability distributions over the key variables affecting electricity consumption within the residential, commercial and industrial sectors for a given level of GDP and population growth.

Using an uncertainty model, a range of energy forecasts was developed, first around each economic forecast and then combining the three economic outlooks.

The result of this analysis is a range of forecasts projected around the probable demand forecast. The probability distribution is expressed in percentiles.

Exhibit 2.1 shows the range of B.C. Hydro's 1989 demand forecasts. Percentile levels for 1999/00 and for 2009/10 are shown in the table below.

Exhibit 2.2 shows the historical accuracy of forecasts developed in previous years.

RANGE OF DEMAND PROJECTIONS

Percentile	Demand (GW.h) in 1999/00	Growth (%) to 1999/00	Demand (GW.h) in 2009/10	Growth (%) to 2009/10
5	46 850	0.9	51 820	1.0
25	53 650	2.2	64 000	2.0
50	58 710	3.0	73 670	2.7
75	64 080	3.8	86 590	3.5
95	69 660	4.6	100 610	4.2

For example, there is a 5% chance that demands will be below 51 820 GW.h by 2009/10 and a 5% chance that demands will be above 100 610 GW.h by 2009/10. There is a 90% chance that the growth rate will be between 1.0% and 4.2% by 2009/10.

Exhibit 2.1

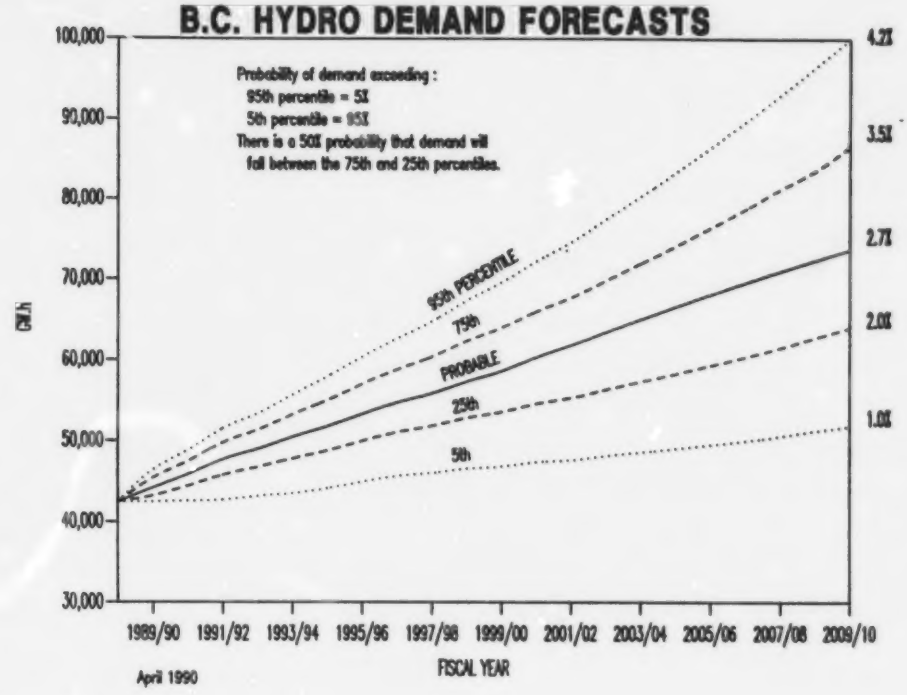
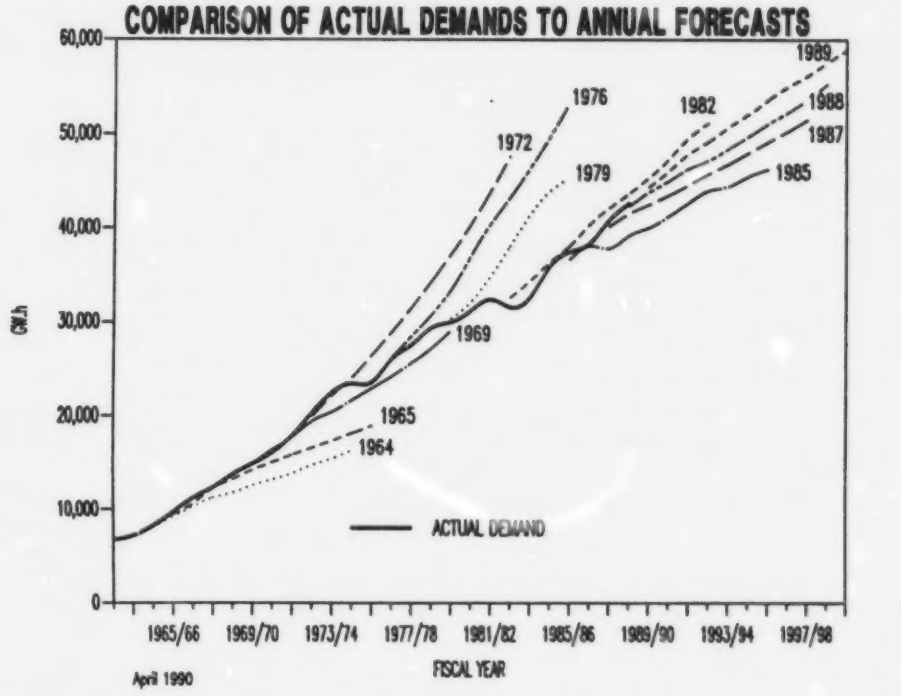


Exhibit 2.2



3.0 DEVELOPMENT OPTIONS

3.1 IDENTIFICATION OF OPTIONS

British Columbia has a number of options which could be utilized to effectively respond to the growing demand for electricity. These options include investment in programs which reduce the growth in demand as well as investments which increase supply. The following is a general discussion about available options. Appendix B provides further detail concerning specific projects.

Demand Reduction

Demand reduction is an important option since it postpones the need for new generation facilities. B.C. Hydro's **Power Smart** programs are intended to reduce the growth in future demand by encouraging customers to use electricity more efficiently in a cost-effective, and environmentally conscious manner.

B.C. Hydro is also working with its large industrial customers and several institutions to encourage them, where it is cost-effective and environmentally acceptable, to self-generate part or all of their own electrical requirements. Cogeneration of electricity and process steam by the forest industry using woodwaste is a good example of the self-generation opportunities that exist in the province. Hydro is willing to consider self-generation projects as they become available to avoid lost opportunities.

Improvements to Existing Facilities

The objective of B.C. Hydro's **Resource Smart** program is to ensure that full economic use is made of the capacity and energy potential of existing generation and transmission facilities. Many Resource Smart projects have little or no environmental impact.

Coordination and Purchase

These include agreements with other utilities or larger industries with electrical generation capability to operate their respective systems in coordination with B.C. Hydro's to produce benefits for both. Hydro recently completed coordination and purchase agreements with Alcan and is continuing discussions with Bonneville Power Administration in the U.S. and with TransAlta Utilities representing the Alberta Interconnected System.

Downstream Benefits

The Canadian Entitlement to downstream power and energy benefits resulting from the Columbia River Treaty was sold in 1964 to the United States for a period of 30 years from the commencement of operation of each Treaty project (Duncan, Mica and Arrow). The Entitlement, commonly referred to as the Downstream Benefits, will gradually revert to British Columbia, beginning in 1998/99. The B.C. Government has not yet decided on the allocation of these benefits within the province.

Hydroelectric Developments

British Columbia has an existing hydroelectric capacity of over 9300 MW. An equivalent amount of environmentally acceptable and economically feasible hydroelectric potential could be developed. The implications of these hydroelectric developments depend on the characterisitics of the project.

In general, additional hydroelectric projects on an already developed river have less environmental impact than a hydroelectric project on an undeveloped river basin. Hydroelectric projects which do not involve the impoundment of water, typically smaller projects, are also expected to have less

environmental impact than projects which involve storage dams.

Transmission requirements are a significant factor for projects in remote locations.

Thermal Developments

There are large coal and natural gas resources in British Columbia. Only the northeast corner of the province has seen extensive exploration for natural gas, although geological studies show potential reserves in other parts of the province and off its coast. B.C.'s abundant coal resources, estimated at 40 billion tonnes have not been used as a significant source of electrical generation in the province.

The major environmental concern associated with burning coal or natural gas for electrical generation is air emissions. These include sulphur dioxide and nitrogen oxides which contribute to acid rain and carbon dioxide which is linked to global warming or the 'greenhouse effect'.

Small to medium size thermal projects could be developed utilizing a variety of waste products such as woodwaste, municipal solid waste (MSW), landfill gases or coal waste. In British Columbia much of the woodwaste produced by the forest industry is already being burned.

Burning MSW is not without concerns about air emissions and public acceptability of these projects. Woodwaste-fired generation will have the mitigating effect of reducing the environmental problems associated with landfilling woodwaste or uncontrolled burning.

Nuclear power is another potential supply option. However, because of low public acceptability and concerns about safety, nuclear power is not considered in electricity planning studies.

Alternative Energy and Emerging Technologies

Alternative energy options in B.C. include solar, wind, geothermal, tidal and wave energy. Many of these options are well suited for small scale development in remote locations. However, for consistency in comparing these alternatives to the other development options, their assessment was based on large scale installations.

In the long term it is expected that some emerging technologies will expand the list of development options. Assessment of their potential contribution has not been attempted but they do remind us of one more aspect of future uncertainty. For example, research into advanced firing technologies may allow the utilization of B.C.'s coal resources in an environmentally acceptable manner or fusion research may result in a breakthrough with this option.

B.C. Hydro is monitoring international technological developments in the area of electricity production. Certain demonstration projects may be approved.

3.2 EVALUATION OF OPTIONS

Each development option has different characteristics and implications. Therefore, each must be evaluated with respect to a number of criteria including availability, public acceptability, cost-effectiveness and environmental and socio-economic impacts. Availability of the option, its estimated cost and the uncertainty of its cost were assessed with respect to information on proven sites in the province. The impact on transmission requirements was assessed on the basis of both cost and environmental impacts. To maintain a reliable system, B.C. Hydro considered only projects with proven availability and which utilize proven technologies. Weights were assigned to the evaluation criteria based on

B.C. Hydro's judgement. These judgements may be adjusted in the future to reflect changing values.Exhibit 3.1 indicates how the various resource options were assessed. Individuals may differ in their relative assessments.

With this type of analysis, B.C. Hydro has established a preference order for the development of options to meet future electricity needs. The first priority is to reduce future demand with Power Smart. Next is coordination and purchases, followed by Resource Smart, or increased utilization of existing resources. Next, B.C. Hydro will encourage development of private sector supply and customer self-generation. B.C. Hydro expects that many of the private sector developments will be small hydro and waste-fired or gas-fired thermal projects.

Hydro projects in developed river basins are next. Lastly, B.C. Hydro will consider hydro projects in undeveloped basins and new thermal generation.

EXHIBIT 3-1 ASSESSMENT OF OPTIONS

	Availability	Public Acceptance	Cost	Uncertainty	Environmental Impact	Socio-Economic Impact	Transmission Impact	Weighted Sum
Weight[1]	NA	20	15	5	15	5	10	
Power Smart	1	0	1	2	0	0	0	25
Coordination	1	1	1	1	1	2	2	85
Resource Smart	1	1	2	1	1	2	2	100
Hydro								
Small development	1	1	2	2	1	2	2	105
Peace/Columbia	1	2	2	1	2	3	3	150
Undeveloped Basins	1	2	2	2	3	2	3	165
Thermal								
Coal	1	3	2	1	3	1	3	175
Gas	1	2	2	3	2	1	1	130
Nuclear	1	4	2	2	2	3	1	175
Woodwaste	1	1	2	2	1	1	3	110
Alternative Technologies[2,3]								
Wind	2	2	4	3	2	1	3	180
Geothermal	2	2	4	3	2	2	3	185
Tidal	1	2	4	3	3	2	3	200
Municipal Solid Waste	1	2	3	2	2	1	1	140
Emerging Technologies[2,3]								
Fuel Cells	3	2	3	2	1	1	1	125
Fusion	4	2	3	3	1	3	1	140
Wave	3	2	3	3	2	1	3	165
Solar	3	2	4	3	2	1	1	160

1. Impacts are ranked on a scale of 0-4. Smaller numbers indicate greater availability, and public acceptance, lower cost, less uncertainty and less impact. The weights reflect Hydro's current judgements and will be adjusted to reflect changing values. Others may differ in the relative values they place on these impacts.

2. Only large scale developments are considered. The impacts of these options may be quite different for small scale developments.

3. Ongoing monitoring of experience around the world is maintained. Certain demonstration projects may be approved.

4.0 DEVELOPMENT STRATEGY

The development strategy answers the question of how much of each option should be developed and when. It considers the preference ranking of options but also takes into consideration the amount of energy available from each. The development strategy discussed below has resulted in the 1990 Electricity Plan.

Exhibit 4.1 presents B.C. Hydro's 1990 Electricity Plan in table form to show the expected firm energy contribution from each option compared to the 25th to 75th percentile range in the demand forecast. Exhibit 4.2 compares the addition of new electricity supplies to the probable load forecast adjusted for load reduction programs (Power Smart and customer self-generation).

In the 1990's, Power Smart, coordination and Resource Smart initiatives will meet part of the projected demand growth. Purchase agreements with Alcan and the Alberta Interconnected System also contribute to the amount of firm energy capability available. Additional purchases from independent power producers and additional customer self-generation will also be required.

EXHIBIT 4-1

1990 ELECTRICITY PLAN - DEMAND FORECASTS AND FIRM SUPPLIES
Millions of kW.h

					Options In-service at End of Five Year Period			
Fiscal Year Ending March 31st	1991	1992	1993	1994	1995	2000	2005	2010
DEMAND								
25th Percentile	44460	45790	46770	47820	48830	53650	58330	63990
Probable	45880	47700	49010	50520	51860	58710	66630	73670
75th Percentile	47500	49780	51390	53330	55100	64080	74150	86580
Power Smart	300	760	1220	1690	2090	3440	3900	4300
Customer Self-Generation[1]	0	0	325	650	975	1300	1300	1300
Net Demand (Probable)	45580	46940	47465	48180	48795	53970	61430	68070
EXISTING AND COMMITTED SYSTEM								
Firm Hydro	42560	42560	42560	42560	42560	42560	42560	42560
Thermal	3720	3720	3720	3720	3720	3720	3720	1600
Downstream Benefits[2]	0	0	0	0	0	2060	3130	2690
NEW SUPPLY								
Resource Smart	500	600	800	1000	1300	2600	3395	3395
Purchases & Coordination[1]	3040	3015	2615	2215	2345	3520	3520	3520
IPP's[1]	0	50	100	630	2350	2400	2400	2400
Peace Site C[3]	0	0	0	0	0	0	4570	4570
Murphy Creek[3]	0	0	0	0	0	0	0	1450
Other New Generation[3]	0	0	0	0	0	0	0	7720
SURPLUS/DEFICIT								
25th Percentile	5660	4915	4570	4645	6510	7950	10165	11515
Probable	4240	3005	2330	1945	3480	2890	1865	1835
75th Percentile	2620	925	-50	-865	240	-2480	-5655	-11075

Notes:

1. The contribution of these options may be increased to accommodate changes in demand. Deficits would be reduced accordingly.
2. The downstream benefits are a provincial resource. No allocation to any specific demand or utility has been made.
3. The timing of these supplies may be adjusted to accommodate changes in demand.

The contribution from IPP's in the 1990 Electricity Plan is based on the expected outcome of the 1989 request for proposals (RFP) for 150 MW from projects over 5 MW, a second RFP for 150 MW expected in 1990 and the RFP for 25 MW from projects under 5 MW. These proposed projects involve a number of options including small hydro, intermediate hydro, woodwaste, waste coal and natural gas.

Small hydro projects are appealing but the high costs for many of these projects plus the requirements of the environmental review process may reduce the contribution from this resource.

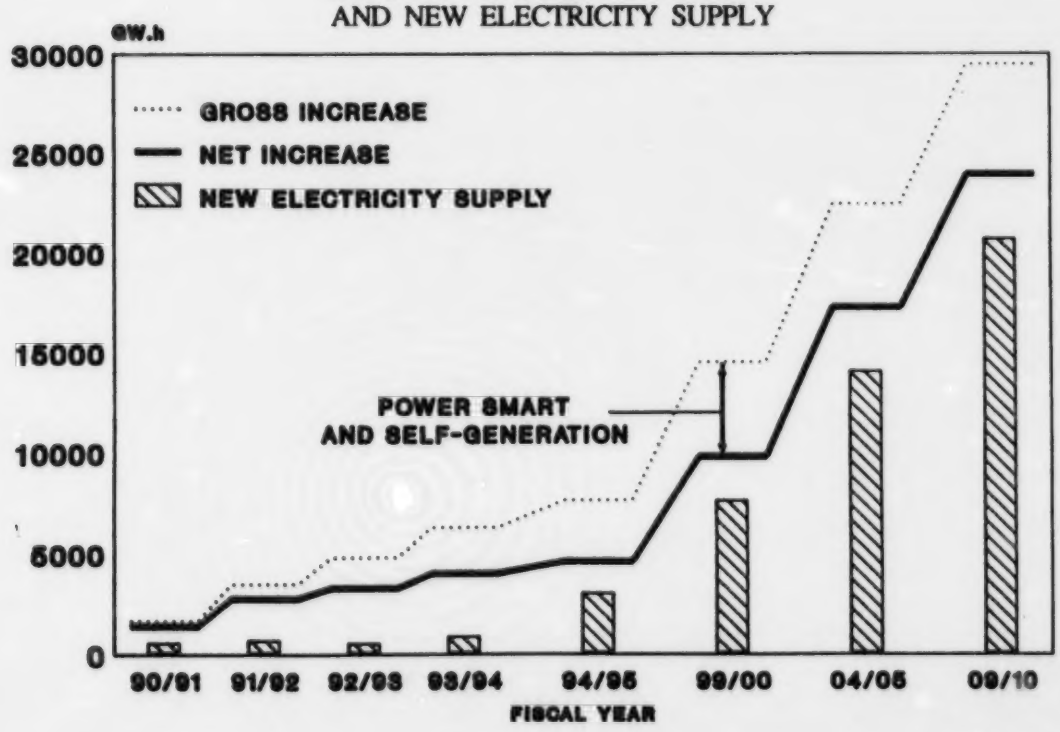
A contribution of 1300 GW.h from customer self-generation including cogeneration was estimated for this year's Electricity Plan.

After the turn of the century the choices are more difficult. Additional Power Smart programs and Resource Smart projects will be required. A Power Smart target of 4300 GW.h per year by 2009/10 has been identified. This includes adjustments for avoided transmission losses.

In addition, to meet a portion of the expected demand, B.C. Hydro proposes to complete the development of the Lower Columbia River and to develop the Peace Site C project. These projects are relatively attractive economically and environmentally.

EXHIBIT 4-2

DEMAND FORECAST INCREASES
AND NEW ELECTRICITY SUPPLY



April 1990

Additional new developments will be required towards the latter part of the 2000s. However specific projects have not been identified to meet these needs.

Once the choice of projects is established, the development strategy must be assessed. Questions such as "Who would build the projects?", "What are the impacts of construction in the local areas?", and "What is the role of major projects?" must be answered.

B.C. Hydro and the provincial government are encouraging private sector participation in the supply of new generation. This emphasis will foster competition for supply options and will lead to lower costs and increased diversity of supply. In this context, many of the projects identified in the Electricity Plan, including both large and small projects, may be available for private sector development.

The Electricity Plan includes several projects in the area of Castlegar and Trail, including five Resource Smart projects (Seven Mile unit 4, Waneta Expansion, Brilliant Expansion, Keenleyside and Duncan), Murphy Creek and Border. B.C. Hydro proposes to schedule these projects to both reduce their construction costs and to reduce disruption to the local economy. The projects' timing will be adjusted to maintain a reasonably stable workforce in the region. This will benefit B.C. Hydro by reducing its costs of re-training workers and benefit the region by reducing the boom and bust cycle that could otherwise accompany this type of development.

5.0 RISK MANAGEMENT

Electricity planning is not an exact science and the risks associated with investments to meet uncertain future needs are significant. Identifying the sources of uncertainty is an important first step. These include uncertainty about future growth in demand, availability of options, availability and price of fuels, interest rates, and regulatory requirements.

As discussed in Section 2, detailed analysis is conducted to quantify the degree of uncertainty in the demand forecast.

The Electricity Plan includes development options which utilize proven technologies. The sequencing of new developments must satisfy energy and capacity reliability criteria. The methodology for scheduling new developments is discussed in Appendix A.

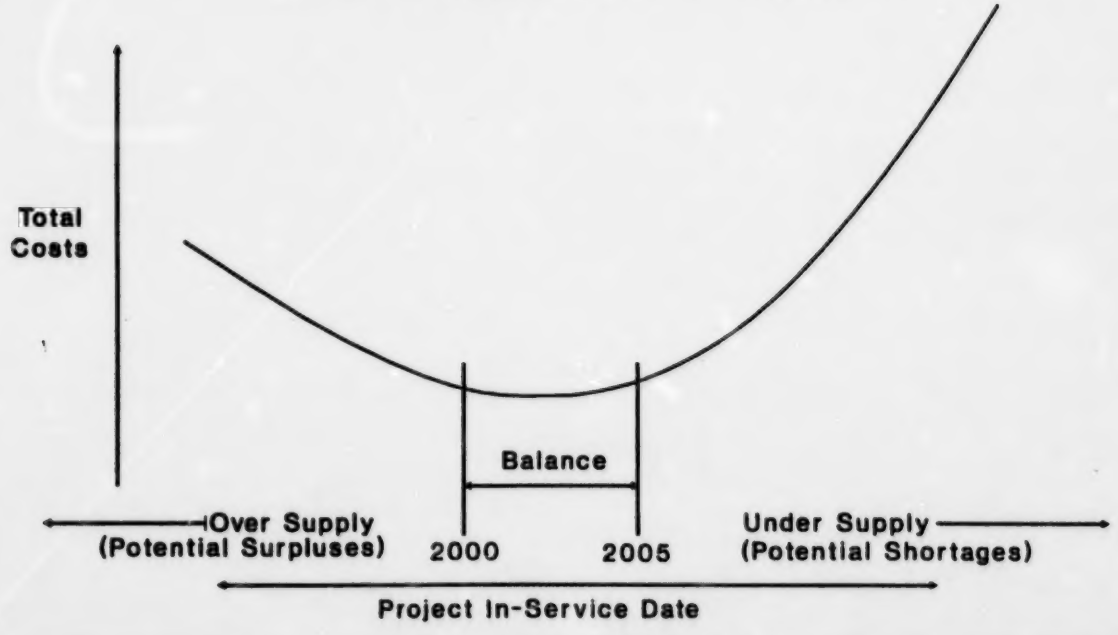
Improvements to the transmission system are also designed to meet stringent reliability standards. It is anticipated that approximately $1.9 billion will be required for reinforcements to the electrical system over the next ten years.

Development options are selected for the Electricity Plan so that the range of possible demand forecasts can be served most economically. The Plan is developed to provide sufficient flexibility such that higher load outcomes can usually be served by resorting to higher-cost options. The risk adjusted cost of capital for new investments is recognized by using an 8% discount rate to assess the cost of each option considered for the Electricity Plan.

The resource development strategy must protect against both the risks of over-supply and under-supply. Over-supply risks occur when projects are built too early, potentially causing energy surpluses. Under-supply risks occur when projects are not built in time and higher cost options must be utilized to meet demands. In the extreme, energy shortages could occur causing increased costs for both B.C. Hydro and its customers. These risks are illustrated in Exhibit 5.1.

EXHIBIT 5-1

OVER/UNDER SUPPLY RISKS



There are three basic elements in Hydro's risk management strategy:

(i) Under-supply risks are reduced by bringing projects to shelf-ready status. This reduces lead times from project approval to project in-service. Options to acquire additional supplies have also been identified.

(ii) Over-supply risks can be reduced by marketing surplus electricity to the U.S. Another strategy would be to offer temporary discount rates to encourage economic development.

(iii) Balancing of these risks is achieved through an on-going review and monitoring process of all current initiatives. The introduction of a portfolio of supply and demand options further reduces the total risk level.

Peace Site C plays a key role in this risk management strategy. Current studies indicate that it will be required by about 2002. However, if demands grow faster than expected, or other resources cannot be developed, the project could be advanced by 1 to 4 years. Engineering work, needed to reduce the time required to bring the project into production after receiving approvals, will be carried out when appropriate.

Similarly, project commitments will be deferred as long as possible to protect against over-supply.

6.0 TRANSMISSION DEVELOPMENT STRATEGY

The overall objective of the transmission development strategy is to shape tomorrow's electric system to assure customers of a reliable, efficient supply of electricity while minimizing effects on the environment. The reliability criteria which the transmission system must satisfy are discussed in Appendix A.

Exhibit 6.1 provides a map of B.C. Hydro's major electrical system. This shows existing and proposed generation and transmission facilities.

The development of the major transmission system is influenced by the location and magnitude of new generation sources and by regional changes in the demand for electricity. Exhibit 6.2 shows the regional balance between generation capability and electricity demand. Increased cooperation with neigbouring utilities in the form of coordination and purchase agreements also affect transmission requirements.

6.1 Interconnecting New Generation Projects

Planning transmission which would connect a new generation source to the system often requires consideration of what other generation projects are being planned or have been proposed for the area. In an iterative way, the selection and timing of generation projects influences transmission requirements and in turn, transmission costs influence the economics of generation options. For example, the development of the transmission system has been a key component of the Lower Columbia Development planning process.

6.2 Corridor Planning

Approximately 70 percent of the electricity produced by B.C. Hydro is consumed in the Lower Mainland and on Vancouver Island whereas most of the generation sources are quite distant from these centres of high electrical consumption. Approximately 75 percent of the forecast increase in provincial consumption over the next ten to twenty years is expected to occur in these two areas.

The planning of transmission corridors into these centres is a major concern to B.C. Hydro. The effects of the corridors on the development of options, land use, the natural environment and people are considered when planning and locating additions to the transmission system. Factors such as joint use of rights-of-way, public concerns about electromagnetic field effects and visual impacts are taken into account when selecting routes.

The availability of transmission corridors is expected to be further constrained in the future. Alternative transmission designs and other technological developments which could limit corridor requirements are being investigated.

6.3 Improvements to the Existing System

The Interior to Lower Mainland transmission system is presently operating at capacity. The Resource Smart program includes assessing the transmission and distribution systems to identify cost-effective opportunities to improve the existing system. Projects include the American Creek Capacitor Station being built north of Hope which will increase the transmission capacity of the two existing 500 kV lines from Nicola substation near Merritt to Meridian and Ingledow substations in the Lower Mainland. Upgrading of the existing 500 kV Peace transmission lines into the Lower Mainland is now under way and should be completed by 1992. This will increase the amount of power that can be transmitted by the existing lines to help meet the increases in electricity consumption expected in the Lower Mainland and on Vancouver Island.

EXHIBIT 6 - 1

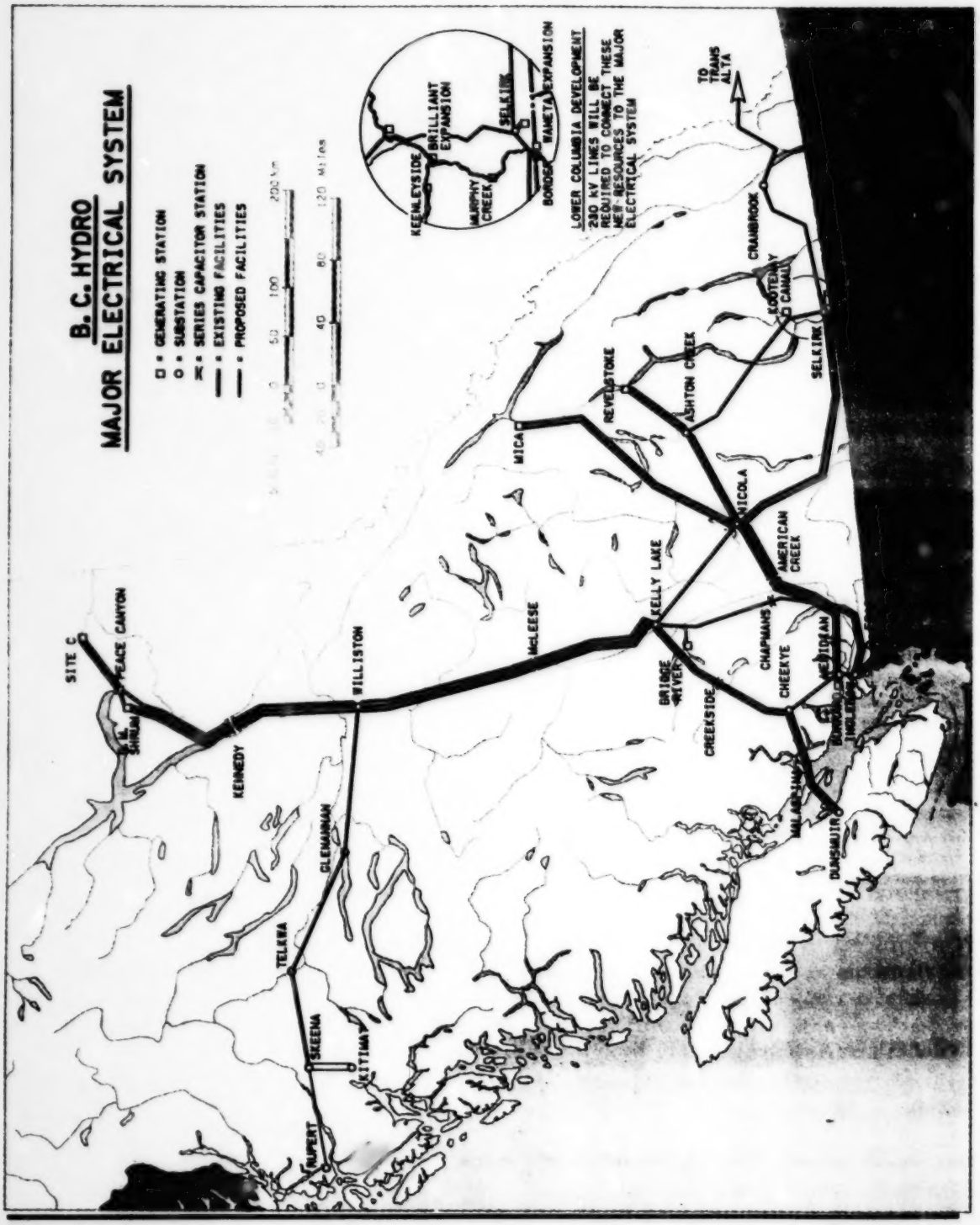
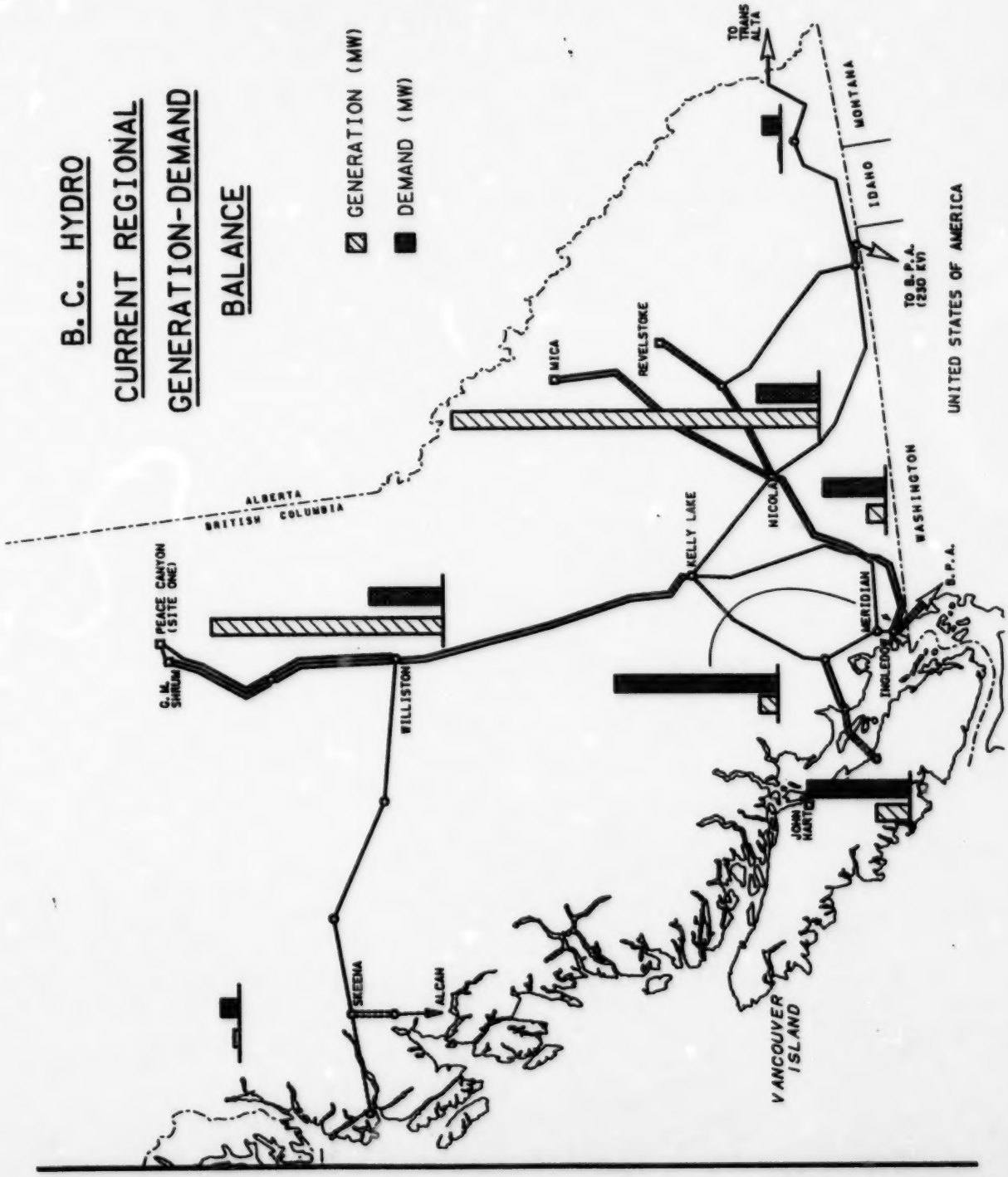

B. C. HYDRO
MAJOR ELECTRICAL SYSTEM
□ = GENERATING STATION
○ = SUBSTATION
⋈ = SERIES CAPACITOR STATION
= EXISTING FACILITIES
= PROPOSED FACILITIES
LOWER COLUMBIA DEVELOPMENT
230 KV LINES WILL BE
REQUIRED TO CONNECT THESE
NEW RESOURCES TO THE MAJOR
ELECTRICAL SYSTEM
KEENLEYSIDE
BRILLIANT EXPANSION
MURPHY CREEK
SELKIRK
BONNER'S FERRY
REVELSTOKE
ASHTON CREEK
CRANBROOK
SELKIRK
TO TRANS ALTA
MICA
NICOLA
AMERICAN CREEK
KELLY LAKE
McLEESE
SITE C
PEACE CANYON
KENNEDY
WILLISTON
BRIDGE RIVER
CREEKSIDE
CHAPMANS
CHEEKYE
MERIDIAN
TELKWA
SKEENA
KITIMAT
RUPERT
DUNSMUIR

EXHIBIT 6 - 2


B.C. HYDRO
CURRENT REGIONAL
GENERATION-DEMAND
BALANCE
GENERATION (MW)
DEMAND (MW)
ALBERTA
BRITISH COLUMBIA
PEACE CANYON (SITE ONE)
G.M. SHRUM
WILLISTON
KELLY LAKE
MICA
REVELSTOKE
NICOLA
MERIDIAN
INGLEDOW
JOHN HART
SKEENA
ALCAN
VANCOUVER ISLAND
TO TRANS ALTA
MONTANA
IDAHO
TO B.P.A. (230 kV)
WASHINGTON
B.P.A.
UNITED STATES OF AMERICA

6.4 System Reinforcements

The transmission system between the Interior and the Lower Mainland is also limited by voltage stability considerations. To avoid blackouts, the system is designed to allow voltage levels to remain within acceptable limits following disturbances.

Planning strategies involve using a mix of reinforcement options. Static var compensators, shunt capacitors, and synchronous condensers, installed at existing substations, are relatively inexpensive and have short lead times whereas new transmission lines are more expensive and require longer lead times. This mix can respond to changing load growth patterns, delays in major project approvals and other uncertainties.

6.5 Impact of IPPs and Wheeling

The location of independent power producers determines their impact on the transmission system. Electricity produced at an Interior location may result in additional loading on the transmission lines down to the Lower Mainland whereas an IPP located in the Lower Mainland or on Vancouver Island could help to offload the transmission system. The impact of IPPs on the transmission system is being considered in the ranking of IPP projects.

B.C. Hydro has provided the British Columbia Utilities Commission with a proposal to allow wheeling on the B.C. Hydro transmission system. This proposal would allow independent power producers to use B.C. Hydro's transmission system, for a fee, to transport power from their generators to serve demands elsewhere in the province. Under this proposal, private suppliers would be able to make their own, potentially long-term, arrangements with electricity consumers at prices advantageous to both. The wheeling fees are set to recover the costs of any new transmission required and to ensure that there is no impact on domestic customers.

6.6 Planned Transmission Developments

Voltage Control Equipment - Installation of shunt capacitors to help maintain acceptable voltage levels is planned this year at Ingledow Substation in Surrey. A static var compensator (SVC) installation is planned for service about 1993 in a Lower Mainland or Vancouver Island substation to provide voltage support to the transmission system. This will allow increased transfers of electricity to these areas. Other shunt capacitor and SVC installations are planned at various Lower Mainland or Vancouver Island substations over the next few years with timing and location depending on actual consumption patterns.

Kelly Lake to Cheekeye 500 kV - A second 500 kV transmission line is proposed for service about 1995 between Kelly Lake substation near Clinton and Cheekye substation near Squamish to provide additional transmission system capacity to serve the increasing consumption of electricity in the Lower Mainland and on Vancouver Island and to help control voltage levels in the Interior to Lower Mainland transmission system.

Nicola to Meridian 500 kV - A second 500 kV transmission line is proposed for service in about 1998 from Nicola substation near Merritt to Meridian substation north of Coquitlam. This line would help control voltage levels and further increase the transfer capability of the Interior to Lower Mainland transmission system to serve the expected increases in customer usage of electricity in the Lower Mainland and on Vancouver Island.

Ingledow to Kidd 230 kV - A new 230 kV line to replace an out-of-service 138 kV line from Ingledow substation in Surrey to Kidd #2

substation in north Richmond is proposed for completion in 1994. This would improve the supply to customers in south and west Vancouver and Richmond.

Fraser Valley Supply - A new 500/230 kV transformer installation and a 500kV connection from a nearby existing circuit are planned at Clayburn Substation near Abbotsford in 1994. This would reinforce the Fraser Valley supply network in response to increasing electricity usage in that area.

Vancouver Island Supply - A new substation is scheduled for completion in 1990 near Lantzville which will be supplied by a loop from a nearby existing 138 kV line. This will increase the capacity and reliability of supply to the growing area north of Nanaimo.

Depending on industrial development in the Port Alberni area, a third 138 kV line, to be designed and constructed for future 230 kV operation, from Dunsmuir substation north of Parksville to Port Alberni may be needed by 1992. A proposed new 230 kV line in the late 1990s, to be initially operated at 138 kV, would strengthen the supply to Harewood substation south of Nanaimo.

Growth in consumption on Vancouver Island could create the need for additional transmission to the Island after the turn of the century. One option being considered is a new 500 kV line from Kelly Lake substation near Clinton to Dunsmuir substation north of Parksville on the Island. This line would not require any submarine cable if an acceptable route across the islands in the northern part of the Strait of Georgia could be found, with land-fall on Vancouver Island in the Campbell River area.

South Interior Supply - New 230 kV lines, to be initially operated at 138 kV, are proposed for 1999 from Cranbrook to Invermere and Golden and from Nicola substation into Merritt substation. These lines would increase the supply capacity to those areas to meet growing customer requirements.

North Coast and Central Interior Supply - A new 230 kV switching station will be constructed in 1990 near the point where the existing line from G.M. Shrum generation plant near Hudson's Hope to Tumbler Ridge crosses the Sukunka River. A 230 kV line from that station will be completed later this year to supply the new Louisiana Pacific pulp mill west of Chetwynd. A second 138 kV transmission line is planned for 1992 from Telkwa substation near Houston to the Smithers substation. This line would provide a firm supply to the community of Smithers as well as to a proposed coal mine development near there.

7.0 ACTION PLAN FOR 1990/91

The following actions will be undertaken during fiscal year 1990/91 to advance implementation of the 1990 Electricity Plan.

Public Consultation

B.C. Hydro, the Ministry of Energy, Mines and Petroleum Resources and the Ministry of Environment continue to sponsor annual electric energy forums. The topic of the forum held this spring in Prince George was "Lifestyles, The Environment and Electricity Use".

Public consultation will continue on several specific projects including Peace SiteC, the Lower Columbia projects, Kelly Lake to Cheekye transmission and potential interties with U.S. utilities.

Power Smart Programs

Power Smart programs will be aggressively promoted in 1990/91 and will build upon initiatives started in 1988 and 1989. An allocation of about $40 million has been made for Power Smart programs in 1990/91.

Several new programs will be introduced. Residential Retrofit will be a comprehensive program for electrically heated homes. An Energy Education school program will be launched in the fall. Building Retrofit will be launched in the commercial sector. The Energy Management Control program will encourage commercial customers to upgrade their current heating, ventilation and air conditioning controls. The objective of the Roadway Lighting program is to have high pressure sodium bulbs in all street light fixtures within 5 years.

A study of the maximum Power Smart potential will be undertaken following public input into the development of the study's terms of reference. The purpose of this study is to explore and recommend various areas of potential improvement in the efficient use of electricity. The costs and practicality of achieving this potential will be addressed from the societal and utility perspective.

Resource Smart

Options to improve the output of B.C. Hydro's existing generation system and to reduce losses on its transmission system will be actively pursued in 1990. A capital budget of $10 million plus an additional $1.8 million for studies and investigations has been allocated to Resource Smart for this fiscal year.

In addition, B.C. Hydro will continue to work with its engineering consultants towards the possible licensing of the Keenleyside project.

Discussions with Cominco on the potential for expansion of the Waneta and Brilliant projects have been initiated and will continue in 1990. Further preliminary engineering studies will also be undertaken on other Lower Columbia projects.

Purchases and Coordination

B.C. Hydro will continue to pursue its proposed agreement with the Bonneville Power Administration for coordinated operation of the Columbia River System. An agreement could lead to studies of further coordinated operation between B.C. Hydro and Bonneville Power Administration.

B.C. Hydro is negotiating with Transalta principles for a coordinated operation agreement with the Alberta Interconnected System. The agreement is expected to be in place by next year and could include provisions for purchasing energy from Alberta as well as exchanges of capacity and energy.

Independent Power Producers

B.C. Hydro expects to finalize discussions with IPPs responding to its call for 150 MW of new generation. Other agreements are expected with a number of IPPs for a further 25 MW of new generation from small power sources. A second request for proposals for 150 MW of generation from IPPs is planned for September 1990.

To provide additional incentives for the development of independent generation, B.C. Hydro will file an application to the B.C. Utilities Commission for the approval of an interim wheeling policy in 1990. This policy, which would be reviewed after two years, will apply to long-term firm wheeling of power to serve demands in B.C.

Self Generation and Cogeneration

B.C. Hydro is presently responding to expressions of interest received pursuant to its request issued in December 1989. The intent of this initiative is to take advantage of these load displacement opportunities as they become available. B.C. Hydro will continue to actively assist its major customers to evaluate their self generation potential and to encourage development in this area.

Contingency Plans

Work is proceeding on Peace Site C environmental and socio-economic studies needed to satisfy concerns about impacts and identify potential mitigation and compensation. A joint provincial and federal hearing on the environmental implications of the Site C project is anticipated. Engineering work, needed to reduce the time required to bring the project into production after receiving approvals, will be carried out when appropriate.

Major Transmission Projects

Construction work will soon start on the third Williston to Kelly Lake 500 kV transmission line and a second Skeena to Kitimat 287 kV transmission line is planned to provide firm transmission capability for the purchase of power from Alcan's Kemano Completion Project.

Preparations will continue for submission of an application for an Energy Project Certificate for the second Kelly Lake to Cheekye 500 kV transmission line. This line will serve load growth in the Lower Mainland and Vancouver Island. Upgrading of the 500 kV Peace transmission lines will continue.

Total expenditures of about $127 million on transmission system reinforcements are budgeted in 1990/91.

Rate Design

B.C. Hydro will continue to analyse how the existing rate structure could be modified to encourage improved efficiency in the production and utilization of electricity. It is expected that an application for changes will be filed with the British Columbia Utilities Commission by the end of 1990.

Export Activities

B.C. Hydro will support the development of export opportunities by studying transmission interties with Puget Sound Power and Light and with Washington Water Power. Construction of either of these interties within B.C. is subject to Powerex establishing sales agreements.

APPENDIX A PLANNING ASSUMPTIONS AND CRITERIA

This appendix provides a review of the technical and economic assumptions used by B. C. Hydro in planning its generation and transmission system. To insure reliable customer service, the system is designed to satisfy a number of criteria which are also discussed.

A.1 CAPACITY VERSUS CAPABILITY

The peak capacity of a generating plant, a transmission line or a total electrical system defines its power output rating in megawatts (MW). The capability of a generating plant or an electrical system is its energy output for a given time interval, typically gigawatt-hours per year (GW.h/a). One gigawatt-hour is equivalent to one million kilowatt-hours. The term demand, also referred to as load, is the amount of electricity required by a customer or group of customers. It is expressed both in terms of maximum (or peak) demand in kilowatts or megawatts and energy demand, for example, kW.h/a.

B. C. Hydro's existing generation system is predominantly hydroelectric. The energy available from the system is dependent on streamflows and the impounding of water with dams to regulate the otherwise large seasonal and annual variations in flow. Developing the generation system to capture the energy available at some hydro sites results in installed generation capacities which exceed the amount required to meet peak system power demands.

The transmission system, on the other hand, must have enough capacity to carry the maximum output from the generation system and to supply the maximum demand from any customer or group of customers.

A.2 GENERATION CAPABILITY

Historical streamflow data from October 1940 to September 1985 is used to determine the energy capability of existing and proposed hydroelectric projects. This historical data is assumed to be representative of the range of inflows that may occur in the future.

The average energy capability of the hydroelectric system is its average annual output over the 45-year period of record. However, the largest load that the generation system can reliably serve is generally limited by the water available during extended periods of low streamflows. The worst low flow period since 1940 occurred between September 1942 and April 1946 and is referred to as the critical period. The largest annual energy demand that can be served without deficits during the critical period defines the firm energy capability of the system.

The existing hydroelectric system has an annual average capability of 46 450 GW.h and a firm energy capability of 42 560 GW.h. For each potential new hydroelectric project computer studies use the 45 year historical streamflow record to estimate average and firm energy capabilities for the project.

B.C. Hydro's one major thermal generating station is the Burrard Thermal plant near Vancouver. At present, it is fuelled with surplus natural gas, called "valley gas", available between March and October. Burrard's firm annual energy capability using valley gas is 3170 GW.h. This could be increased to 5520 GW.h with a firm gas contract. However, the cost of operating the plant with this type of contract would be about one and a half times the cost of operating the plant on valley gas and the flexibility to reduce its output during high streamflow years may be limited.

Two combustion turbine plants, located at Prince Rupert and Port Hardy are primarily intended for operation during transmission interruptions. However, these projects could provide a firm capability of about 550 GW.h to supplement the hydroelectric system in low water conditions.

Therefore, the total firm energy capability of the existing system is about 46 280 GW.h per year. Additional energy available in better streamflow years is referred to as secondary energy. On average, the existing hydroelectric system produces 3890 GW.h of secondary energy annually.

A.3 SCHEDULING NEW RESOURCES

Planning studies are conducted to develop plans from which the Electricity Plan is selected. In these studies, a mathematical procedure is used which considers all potential combinations of future energy demands and availability of energy from existing and planned facilities. The procedure calculates the expected usage of each facility included in a particular study. Typically, higher load outcomes are served by resorting to higher-cost options. The expected cost of meeting domestic energy demands over the long-term is calculated.

In some adverse combinations of demand outcome and energy availability, not all demand can be served. The probability and extent of such deficits is calculated and serves as a measure of the risk inherent in each alternative plan considered. In planning the generation system, development options are scheduled so that the following reliabilty criteria are satisfied.

The energy reliability criterion requires that the expected amount of unserved energy demand in any given year must be less than 0.8% of the total annual energy demand. The peak reliabilty criterion requires that expectations of having insufficient generating resources available to meet the forecast daily peak load should be one day in 10 years, or less.

Assuming the reliability criteria are satisfied, the selection of an electricity plan depends on the planning objectives. Based on economic objectives, a plan would be selected such that the expected cost of serving long-term domestic demands is minimized. Electricity plans can also be developed to meet other planning objectives.

The costs of the major additions to transmission and stations equipment required to transmit energy and capacity to the load centres are included in each alternative plan evaluated. Transmission line losses are treated as an additional load. Power Smart and customer self-generation are assumed to reduce transmission requirements so their contributions are adjusted upwards to more accurately reflect the generation they displace.

A.4 TRANSMISSION CONSIDERATIONS

Electricity in B.C. is predominantly consumed in the Lower Mainland and on Vancouver Island. Since the major generation sources in B.C. Hydro's system are several hundred miles removed from this demand, high voltage transmission lines, typically 500 kV, are required to transmit the electricity economically. The high voltage lines terminate at central substations from which area transmission lines operating at 138 kV or 60 kV provide electricity to large industrial customers and to local area substations. Distribution lines deliver the electricity from these substations to smaller industrial, commercial and residential customers.

Maintaining adequate reliability requires that the system voltages remain relatively constant during times of high customer usage and that when system disturbances do occur, there is no loss of generation output or interruption of electricity supply to customers. The long distances and the large variability in customer usage during the day and at different times of the year also require that equipment be installed to regulate system voltages and to maintain system stability. Sophisticated control and communication systems are required to operate the electrical system and to protect it during disturbances.

Transmission planning criteria require that the short term maximum output can be transmitted from any facility and the short term maximum consumption can be supplied to any customer or group of customers. Also, the transmission system is designed to be capable of withstanding the failure of a single major system element during times of peak electricity usage and other high stress conditions. Following a failure, no equipment should be operating beyond its emergency design limits. There should be no loss of generation output or interruption of electricity supply to customers. In addition, as a member of the Western Systems Coordinating Council, B.C. Hydro must demonstrate that a disturbance within the B.C. Hydro system will not adversely affect the systems of neighbouring utilities.

Criteria vary for the area transmission system and for substations depending on where the facilities are located, on customer requirements and on the cost of providing protection against failures of a single element.

A-5 ECONOMIC CONSIDERATIONS

The discount rate is used to convert revenues and expenditures occurring in different periods to a common present value basis. The appropriate discount rate can vary depending on the analysis. B.C. Hydro, in consultation with the provincial government, has adopted an 8% net of inflation discount rate to evaluate its development options. This rate reflects the average pre-tax return to public and private investment in Canada and trade-offs between savings and consumption. Once a commitment has been made to proceed with a project, a 5% net of inflation discount rate may be utilized for selected project optimization studies to ensure that options are developed to their full economic potential. The lower discount rate is also more appropriate for assessing environmental impacts and the value of foregone opportunities to future generations.

Corporate Overhead costs are allocated to B.C. Hydro projects as a function of their size, which in turn is characterized by the expenditures involved. For example, for projects with a total cost including allowance for inflation of between $1000 and $10 000 the overhead rate is 16.0 percent. For projects costing between $11 million and $26 million, the overhead rate is 5.0 percent. This decreases to 3.5 percent for projects costing over $1 billion.

Operating Costs of new projects include both fixed and variable costs. Fixed operating costs are based on B.C. Hydro's past operating experience. They include operations and maintenance, administration and general expenses, insurance, grants and school taxes, and interim replacements. Variable costs are primarily fuel costs and the energy portion of the water rental fees for hydroelectric projects. The following table provides operating costs for a variety of projects in October 1990 dollars.

OPERATING COSTS FOR NEW PROJECTS

Project Type	Fixed Annual Cost *	Plant Life (years)	Variable Cost (¢/kWh)**
Hydroelectric	1.8	70	0.4
Thermal (gas/oil)	4.0	35	0.7
Thermal (coal)	2.2	35	0.1
Combustion Turbine	3.0	30	-
Transmission (steel)	1.9	45	-
Transmission (wood pole)	1.9	30	-
Substations	1.2	30	-

Note: * As a percentage of total project construction cost, excluding corporate overhead and interest during construction.

** Subject to annual escalation. Fuel costs are excluded. Energy portion of annual water rental allowance are included for hydroelectric projects.

APPENDIX B DEVELOPMENT OPTIONS

B.1 DEMAND REDUCTION OPTIONS

Power Smart

Power Smart is a series of B.C. Hydro programs aimed at achieving cost-effective demand reduction. The following table summarizes currently projected costs and energy savings for Power Smart programs by sector. As well, information programs have been developed as part of Power Smart. They are aimed at achieving enduring changes in consumption by shifting customers' attitudes concerning electricity use.

Since launching Power Smart in March 1989, B.C. Hydro has received valuable experience in the design and delivery of demand-side management programs. Initial 'top down' estimates of conservation potential have been developed. The preliminary estimate of the size of the technical potential for residential, commercial, and industrial sectors is 32 percent of existing demand, while the economic potential and marketing potential are estimated to be 22 and 11 percent respectively. The largest marketing potential would appear to be in the residential sector while the commercial sector offers the largest technical and economic potential.

Hydro is now preparing to assess more completely the potential for conservation in the different sectors of the B.C. economy. The framework for this assessment is presently being developed.

Customer Self-Generation

Customer self-generation or load displacement is generation of electricity by customers for their own use, thereby reducing their requirements from B.C. Hydro. Cogeneration is a type of self-generation in which significant efficiency improvements can be achieved because electricity and process steam are produced simultaneously. The total potential for self-generation in the forest industry, much of which would be cogeneration, has been estimated by B.C. Hydro at about 500 MW. At this time, the economics of many of the projects comprising this total are uncertain.

POWER SMART PROGRAMS

Sector	Projected Energy Saving		Unit Cost
	by 2009/10 (GW.h/a)	20 year total (GW.h)	(¢/kW.h)
RESIDENTIAL	689	9908	3.6
COMMERCIAL	2047	28229	2.3
INDUSTRIAL	944	10640	1.0

Unit cost is based on the total (B.C. Hydro plus customer) costs and energy savings over the 20 year period. An 8% discount rate was used.

In December 1989, Hydro requested expressions of interest for self-generation from its major customers. The response has been very encouraging and B.C. Hydro is presently working with a number of customers to help assess their self-generation potential.

B.2 SUPPLY OPTIONS

Resource Smart

Resource Smart is B.C. Hydro's name for a program intended to make existing facilities more efficient and thus obtain significant additional energy and capacity from the B.C. Hydro system. Additional energy may be obtained from existing plants by various means such as adding additional generating equipment, retrofitting with more modern equipment, raising operating levels of reservoirs, diversions of additional water and improvements to maintenance procedures.

At present, 3400 GW.h of annual energy savings resulting from efficiency improvements are economically attractive and considered to be environmentally acceptable.

Several projects proposed for the Lower Columbia River are Resource Smart projects. Keenleyside, Seven Mile and Duncan projects involve installation or addition of generating facilities at existing B.C. Hydro dams while Waneta and Brilliant projects would involve additional generating facilities at existing Cominco Dams. In total these projects would contribute about 2100 GW.h of the 3400 GW.h Resource Smart contribution of firm energy.

Coordination and Purchase Agreements

Alcan is proceeding with the construction of the Kemano Completion project for service by 1995, ahead of the company's requirements for industrial purposes. An agreement on coordination and purchases was signed in February 1990. The long-term purchase agreement will provide B.C. Hydro with 2500 GW.h/a of firm energy for a period of 20 years. In addition, coordinated operation of Alcan and B.C. Hydro reservoirs is expected to yield a net gain of 260 GW.h/a (firm) to B.C. Hydro.

Bonneville Power Administration (BPA) and B.C. Hydro are investigating the potential for coordinated operation in addition to the Columbia River Treaty and the existing agreement on the use of non-treaty storage. This would make it possible to use B.C. Hydro's reservoir storage on the Peace and Columbia rivers more effectively. Current negotiations with BPA are aimed at reaching a limited coordination agreement for the operation of additonal non-treaty storage on the Columbia River in 1990. This would provide 750 GW.h of firm energy to B.C. Hydro. BPA and B.C. Hydro have agreed to study alternatives for future coordination when this agreement is in place.

TransAlta Utilities Corporation on behalf of the Alberta Interconnected System (AIS) and B.C. Hydro are investigating the potential for coordinated operation of the two systems. The AIS is a predominantly thermal generation system in contrast to B.C. Hydro's hydroelectric system. Due to the differences in the technical characteristics of these two systems it is beneficial to both parties to coordinate the operation and possibly the planning of new developments for these systems.

Pending the outcome of current discussions, B.C. Hydro has assumed that up to 2000 GW.h/a of off-peak coal-fired energy and up to 2000 GW.h/a of off-peak natural gas-fired energy would be available to B.C. Hydro at competitive prices. In the short-term at least 1000 GW.h/a of coal-fired energy and 1000 GW.h/a of natural gas-fired energy is assumed to be available to B.C. Hydro whenever needed. In the longer term, since Alberta

may develop alternative uses for some of this energy, it is assumed that no set minimum amount of this energy would be available, but a combined maximum of up to 4000 GW.h/a could be available.

The transmission implications of coordination and purchase agreements must be taken into account. For example, the energy purchase from Alcan has been a major factor in determining the need for a third 500 kV transmission line between Williston substation near Prince George and Kelly Lake substation near Clinton. In addition, a second 287 kV line between Kitimat and Skeena substation near Terrace will be needed to provide for the increased flow of electricity from Kemano to the B.C. Hydro system.

Downstream Benefits arising from the Columbia River Treaty

The Canadian Entitlement to downstream power and energy benefits resulting from the operation of storage at the Duncan, Keenleyside and Mica projects under the Columbia River Treaty was sold to the United States for a period of 30 years from the commencement of operation of each project. The Entitlement, commonly referred to as the Downstream Benefits or DSBs will revert to British Columbia gradually, beginning in 1998/99. The benefits will continue until at least 2024 which is the earliest date the Treaty can be terminated. The B.C. government has not yet allocated the DSBs to any utility or end-use.

The magnitude of the DSBs depends on the rate of electric load growth in the northwest United States and on the amount of thermal and hydroelectric facilities used to serve this load growth. In addition to energy, the DSBs include a substantial peak capacity component.

Canadian Entitlement to Columbia River Treaty
Downstream Power Benefits Accruing to British Columbia

	Energy (GW.h)			Capacity (MW)
	Low PNW[2] Growth	Probable PNW Growth	High PNW Growth	All Forecasts
1998/99	620	480	360	100
1999/00	3670	2790	2060	600
2000/01	3670	2760	1990	600
2001/02	3680	2730	1920	600
2002/03	3690	2700	1850	600
2003/04	6600	4810	3230	1100
2004/05	6620	4760	3130	1100
2005/06[1]	6640	4710	3030	1100

(1) Benefits continue until at least 2024 (the earliest date the Treaty may be terminated). Benefits decline slightly each year as the U.S. system grows.

(2) Pacific Northwest Region of the United States

Both the capacity and energy benefits are expected to decline slightly with time as the U.S. system grows. The table provides estimates of the Downstream Benefits.

Specific transmission requirements for the return of the DSBs have not yet been identified. These requirements must be jointly developed by the U.S. and B.C. Hydro. Studies have been initiated to address this issue.

Hydroelectric Projects on Developed River Basins

The Peace Site C project and two additional projects on the lower Columbia River, Murphy Creek and Border, are hydroelectric options which involve the two major B.C. rivers which have already been developed.

The Peace Site C project would be located on the Peace River, 7 km southwest of Fort St. John. The project's firm annual energy capability would be 4570 GW.h and its average annual energy capability would be 4710 GW.h. An 80 km long reservoir would extend upstream to Peace Canyon dam. The reservoir would flood 4600 hectares of land, of which approximately half is considered to have agricultural value. The remainder contains a variety of forestry, wildlife and heritage resources.

Two 500 kV transmission lines would be required to integrate the proposed Site C development. The two lines would be routed from Site C to the existing Peace Canyon generating plant near Hudson's Hope along an existing right-of-way.

Unlike the five Resource Smart projects on the lower Columbia Development which involve existing facilities, Murphy Creek and Border projects would require construction of new low-head dams and power plants. Murphy Creek would have a firm annual energy output of 1710 GW.h and Border would provide 1510 GW.h.

New 230 kV transmission would be needed to connect the proposed Lower Columbia development projects to B.C. Hydro's system. These projects in addition to the possible purchase and coordination agreements with the Alberta Interconnected System could create a need for a second 500 kV transmission line between Selkirk substation and Nicola substation near Merritt. B.C. Hydro is currently studying a number of options for the transmission system in this area and public input into the planning process is being sought.

Hydroelectric Projects on Undeveloped River Basin

Beyond the development of the above projects, hydroelectric development in B.C. would involve rivers which are presently undeveloped. The environmental impacts of such projects are expected to be significantly greater. Potential projects include the following:

Project	Nominal Capacity (MW)	Average Energy (GW.h/a)
Elaho	340	2100
Lower Canyon	360	1950
Homathko	895	4360
Stikine/Iskut	2900	15 570
Liard	3190	18 380

The Lower Canyon project would be situated on the McGregor River which is a tributary of the Fraser. The Elaho River is located about 50 km northwest of Squamish and the Homathko River is located in the Coast Mountains 270 km north of Vancouver. These projects are close to the existing transmission grid or are close to the major population centres. The Elaho project and Lower Canyon could provide flood control on the lower Squamish River and the Fraser River, respectively. These projects would involve the construction of

new dams resulting in the loss of forest land and would affect fish and wildlife. The Homathko project would flood part of the heritage Waddington Wagon Road.

The Stikine/Iskut and Liard projects are remote projects with significant environmental and social impacts as well as international (Stikine) and interprovincial (Liard) implications.

Thermal Developments

Coal-fired Thermal - This could include major new developments such as the proposed Hat Creek project considered for development in the late 1970's. Hat Creek was postponed indefinitely in 1982.

Waste-fired Thermal - These would generally be small to medium developments utilizing a variety of waste products such as woodwaste, municipal solid waste, landfill gases or coal waste. In some cases, such as wood, the waste products are already being burned.

Gas-fired Thermal - Thermal generation utilizing natural gas has the advantage of being relatively inexpensive and established technology. However, future costs of fuel are less certain. New developments would likely utilize more advanced technology resulting in higher efficiencies.

APPENDIX C MARGINAL COST OF ELECTRICITY

The marginal cost of electricity represents the average cost of satisfying an additional domestic demand for electricity. In the near-term, when the resource schedules are fixed, this is the cost of additional electricity from existing or committed facilities or the reduction of interruptible sales. In the long term, as existing and committed resources are fully utilized, the marginal cost of electricity represents the cost of providing electricity from new generation sites. The timing and sequencing of projects as specified in the Electricity Plan determine the marginal cost of electricity.

The marginal cost of electricity is used to assess the value of obtaining electricity from alternative sources. It is used as a preliminary screening tool to evaluate new projects, modifications to existing facilities, energy purchases and conservation programs.

The current marginal cost of electricity and its components, firm capacity and firm energy, are provided in the following table and in Exhibit C.1. The table also shows the marginal cost of reducing secondary energy production. Since the cost of electricity includes the cost of transmission, it varies with location. The quoted values are for the Lower Mainland.

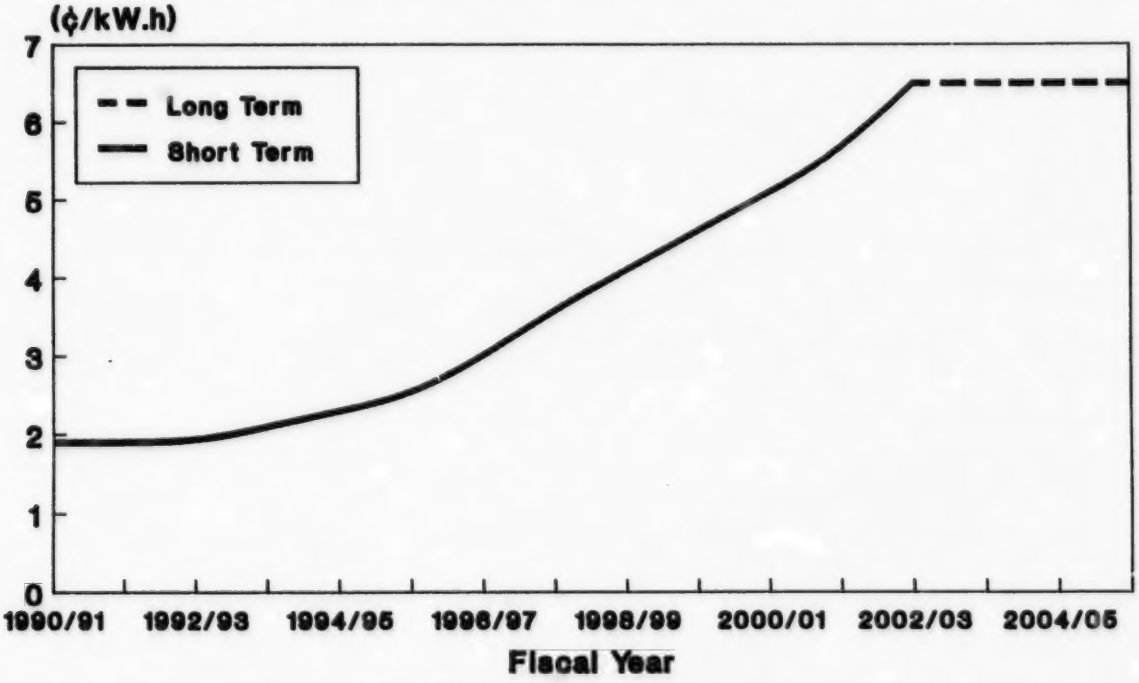
MARGINAL COST OF ELECTRICITY IN THE LOWER MAINLAND
(October 1990 dollars uninflated)

	Electricity (¢/kW.h)	Firm Capacity $/kW/a	Firm Energy (¢/kW.h)	Secondary Energy (¢/kW.h)
1990/91	1.9	6.0	1.8	1.1
1991/92	1.9	6.0	1.8	1.1
1992/93	1.9	6.0	1.8	1.1
1993/94	2.1	14.0	1.8	1.1
1994/95	2.3	23.0	1.8	1.1
1995/96	2.5	32.0	1.9	1.1
1996/97	3.0	40.0	2.2	1.4
1997/98	3.6	51.0	2.6	1.6
1998/99	4.1	59.0	2.9	1.8
1999/00	4.6	59.0	3.4	2.0
2000/01	5.1	59.0	3.9	2.1
2001/02	5.6	59.0	4.4	2.1
2002/03 and after	6.5	59.0	5.3	2.1

NOTE: The system capacity factor adjusted for a 10% reserve margin is 58%. Therefore, assuming there are 8760 hours in a year, each kilowatt of capacity would generate 5081 kW.h/a. and a capacity cost of $59/kW/a is equivalent to 1.2¢/kW.h .

EXHIBIT C - 1

MARGINAL COST OF ELECTRICITY •
Delivered To The Lower Mainland



• Energy and Capacity
In October 1990 Dollars

April 1990

GLOSSARY

Capability: The energy output of a generating station or the integrated system under specified conditions for a given time interval (usually one year).

Capacity: The rating of the output from a generating station or the system. Several capacity values may be identified, as follows:

- -Maximum: the maximum output that can be achieved.
- -Nameplate: the maximum output specified by the manufacturer.
- -Dependable: the maximum output that can be reliably supplied during peak load months (December and January).
- -Firm: based on dependable capacity, unit availability and system characteristics; computed from a reliability analysis.

Cogeneration: The simultaneous production of mechanical or electrical energy and useful thermal energy in the form of steam or hot water from a single fuel source.

Coordination: Pooling of resources and/or loads between utilities to allow more efficient operation. Coordination, involving joint reservoir management, may increase the annual availability of firm energy from the existing hydroelectric plants in the B.C. Hydro system. It may enable each participating utility to defer new power plant construction.

Commercial Sector: Service industries including retail, community, transportation, communications, construction and other utilities.

Critical Water Conditions: A period of adverse stream flows which actually occurred during the past. Critical water conditions serve as a design test of the capability of a hydroelectric system to meet forecast electric loads under adverse reservoir inflows. During a critical period all hydroelectric reservoirs would be drawn down to minimum levels in order to sustain service.

Demand: The amount of electricity required by the system or by the customers.

Demand-side Management: Actions that influence demand to better match available supplies.

Firm Energy: The assured energy contribution (kWh) of generating plants over one year. For the B.C. Hydro system the firm energy capability is based on the average annual energy available during an extended period of adverse stream flows (the critical period).

GigaWatt Hour (GW.h): One million kW.h. B.C. Hydro measures the energy output of generating stations in Gigawatt hours.

- -Vancouver uses about 4000 GW.h each year.
- -Prince George uses about 2000 GW.h each year, half of which goes to serve industrial customers.
- -Victoria uses about 690 GW.h each year.
- -Vernon uses about 180 GW.h each year.

Independent Power Producer (IPP): A person or company whose independent generating facility is connected to a utility system such that electricity may be sold to the utility.

Industrial Sector: Manufacturing industries including pulp and paper, wood products, mining, metals and coal, and chemical and petroleum products.

Integrated System: The interconnected network of transmission lines and substations linking generating stations to one another and to customers. Also representing that portion of the B.C. Hydro electric system capable of being operated on a coordinated basis.

Interconnection Facilities: Components in the substation (and transmission in some cases) that connect the generator to the B.C. Hydro system, plus any other facilities required to integrate the generator with the B.C. Hydro system.

Load: The amount of electricity required by a customer or group of customers.

Load Displacement: The freeing of electricity from an existing customer's load (future or present) by using electricity more efficiently to perform the same amount of work (i.e. lighting, torque, etc.), or by the addition of customer self-generation.

Marginal Cost of Electricity: The marginal cost of electricity represents the average cost of serving additional domestic demand for electricity.

MegaWatt: One thousand kilowatts (kW), commonly used to measure the capacity of generating stations.

Non-integrated Areas: B.C. Hydro service areas, remote from the integrated system and usually supplied by a local diesel generator.

Peak Demand: The maximum amount of electricity required by the system or by the customers. For B.C. Hydro, peak demands normally occur in the evening of winter months and are generally averaged over one hour.

Power Smart: Collective name given to B.C. Hydro's strategy to improve the efficiency of electricity use. The reduction in future additional demand will help to defer large capital outlays and finance charges associated with new power plant construction.

Request for Proposal: Document(s) issued by B.C. Hydro describing the necessary arrangements for the utility to purchase electricity supply (or load displacement) from independent power producers.

Residential Sector: All single electric metered dwellings occupied by customers, and used as residences.

Resource Smart: Collective name given to B.C. Hydro's strategy of ensuring that full economic use is made of the capacity and energy potential of its existing facilities so that major new project construction may be deferred as long as possible.

Secondary Energy: The energy that is available when water conditions are such that there is more than enough water to refill the system's reservoirs and to generate its firm capability. Secondary energy is not guaranteed to be available.

Self-Generation: Generation of electricity by a customer for its own use. Self-generation can include cogeneration.

Supply-side Options: Generic descriptions of all alternatives that increase generation output, such as new generation projects, coordination and purchases, and improvements to existing facilities.

Transmission Losses: Energy lost as dissipated heat caused by electrical resistance inherent in all components of the electric system that carry current.

Water Licence Fee: Annual payment to the Provincial Government in respect to the amount of electricity generated, the acres of land flooded, the installed plant capacity, the volume ow water stored, etc. Also known as water rental fees.

Wheeling: The transmission of electric power from one system to another (often from a producer to a consumer) through a third party (usually the owner of the transmission facilities).